HUMAN BIOLOGY
a record of research
FEBRUARY, 1938
VOL. 10 No. 1

POPULATION GROWTH, EQUILIBRIA, AND EXTINCTION UNDER SPECIFIED BREEDING CONDITIONS: A DEVELOPMENT AND EXTENSION OF THE THEORY OF THE LOGISTIC CURVE

BY VITO VOLTERRA

Rome

PROFESSOR D'Ancona has asked me if it is possible to state the mating conditions under which a population living under defined environmental conditions will decrease and vanish or on the contrary continue to grow steadily larger.

1. We can give a criterion to distinguish these two cases and settle a critical value of the population such that for a smaller value the population exhausts itself, and for a larger one, increases.

2. Let N be the population and ϵ the mortality coefficient. If we suppose that the ratio of the males to the females remains constant, the number of the males will be αN and the number of the females βN, α and β being two constants such that $\alpha + \beta = 1$. The number of the meetings of the two sexes in a unit of time will be proportional to $\alpha N \cdot \beta N = \alpha \beta N^2$; and if the birth of m individuals corresponds to n meetings, the number of the births in a unit of time can be expressed by:

$$K \alpha \beta \frac{m}{n} N^2 = \lambda N^2$$

K and λ being two positive constants. It results from this that in a time dt we have:

$$dN = -\epsilon N\,dt + \lambda N^2\,dt$$

that is:

$$\frac{dN}{dt} = (-\epsilon + \lambda N)\,N.$$

3. This equation is identical to the equation of Verhulst-Pearl, except for the signs of the coefficients which are interchanged.

Thus if we take the Verhulst-Pearl integral with the necessary sign-interchange, we get the formula:

$$N = \frac{-\epsilon N_0 e^{-\epsilon t}}{-\epsilon - N_0\lambda\,(e^{-\epsilon t}-1)} = \frac{\epsilon N_0}{(\epsilon - N_0\lambda)\,e^{\epsilon t} + N_0\lambda} = N_0\frac{1}{(1-h)\,e^{\epsilon t}+h}$$

in which N_0 is the initial population at the epoch $t = 0$ and $h = N_0\frac{\lambda}{\epsilon}$.

4. We can then distinguish three cases:

(1) $\epsilon - \lambda N_0 = 0$ (i.e. $h = 1$)

(2) $\epsilon - \lambda N_0 > 0$ (i.e. $h < 1$)

(3) $\epsilon - \lambda N_0 < 0$ (i.e. $h > 1$)

In the first case the population N *remains always constant* and equal to $\frac{\epsilon}{\lambda} = N_0$. In the second case, when t increases indefinitely, the denominator increases indefinitely and N tends to zero, and therefore the population tends to vanish. In the third case, the denominator decreases and becomes zero when

$$e^{\epsilon t} = \frac{N_0\lambda}{N_0\lambda - \epsilon}$$

i.e. at the epoch $t = \frac{1}{\epsilon}\log\frac{N_0\lambda}{N_0\lambda-\epsilon}$, we have $N = \infty$.

Of course this occurrence cannot happen; other causes lessen the increase of the population.

Thus a critical value $N_0 = \frac{\epsilon}{\lambda}$ *exists above which the population grows continuously but below which it decreases and vanishes. When* $N_0 = \frac{\epsilon}{\lambda}$, *the population remains stationary.*

5. The case of the vanishing can be verified, but of course the case in which the population increases indefinitely and becomes infinite after a finite time is not a realizable one. There must exist some cause which lessens the endless increase.

In the case considered by Pearl which leads to the logistic curve, it is supposed that with the increase of the population the means of subsistence become rarefied and a negative term proportional to the already existing population must be added in the increase coefficient. It would be possible to think that in our case too Pearl's term $-\mu N$ (μ being positive) must be added in the increase coefficient $-\epsilon + \lambda N$. In this manner the latter would become $-\epsilon + (\lambda - \mu) N$. But, if $\lambda - \mu$ is positive we find again the case we have already treated; otherwise, $\lambda - \mu$ is negative and then we have a rapid decrease of N until N becomes zero.

6. We can consider all the cases in which the increase coefficient is linear in N. The equation takes then the form

$$\frac{dN}{dt} = (a + bN)\,N\,, \qquad \text{(i)}$$

and we can distinguish four cases:

(1) $a > 0, b < 0$

(2) $a < 0, b > 0$

(3) $a > 0, b > 0$

(4) $a < 0, b < 0.$

The integral of equation (i) is:

$$e^{t} = \left(\frac{N}{N_o} \cdot \frac{a + bN_o}{a + bN}\right)^{\frac{1}{a}}, \text{ i.e. } N = \frac{N_o a}{(a + bN_o)\,e^{-at} - N_o b}.$$

The first case is Pearl's and leads to the logistic curve.

The second case is the case we have just discussed.

The third leads to $N = \infty$, for $t = \frac{1}{a}\log\left(\frac{a + bN_o}{bN_o}\right)$. But an infinite increase after a finite time is impossible.

The fourth case leads to $N = 0$ for $t = \infty$; and is thus the extinction case.

7. We have seen that by the allowance of a restraint similar to Pearl's, i.e. a decrease proportional to the increase of the population, we add nothing essentially new to the study already made.

The failure is due to the fact that the increase coefficient is a linear function of the population. But it is obvious that, by examining the question more profoundly, we can succeed by logic and natural means in establishing for the said coefficient a second degree polynomial. In this manner the resulting demographical phenomenon becomes entirely altered.

In fact we supposed that to n meetings between individuals of different sexes would correspond m births, but the hypothesis of a constant ratio between the births and the meetings can be admitted only as a first approximation.* If we wish to consider the possible cases with greater accuracy, it is necessary to suppose that this ratio can be influenced by the population itself, and not solely by the rarefaction of the means of subsistence which results from the increase of the population. As a first approximation we can suppose, as it is done in analogous cases, that this ratio decreases linearly with the population. The birth number in a unit of time will be expressed by:

$$K \alpha \beta \frac{(m - \rho N)}{n} N^2$$

ρ being positive; i.e. by

$$(\lambda - \gamma N) N^2$$

λ and γ being positive.

8. Thus if we take into account the *mortality coefficient* $-\epsilon$, *Pearl's term* $-\mu N$, and the *birth term* $(\lambda - \gamma N) N$, we shall obtain the increase coefficient:

$$-\epsilon + (\lambda - \mu) N - \gamma N^2,$$

from which it results that (i) is replaced by

$$\frac{dN}{dt} = \left(-\epsilon + (\lambda - \mu) N - \gamma N^2 \right) N$$

or

$$\frac{dN}{dt} = -(c - bN + aN^2) N \qquad (i')$$

where a and c are positive.

---

* Compare R. Pearl and S. L. Parker. *Proc. Nat. Ac. of Sci.* Vol. 8, 1922.

We will suppose too that b is positive, keeping the case of b negative apart for the present.

Let us suppose that the roots of the equation

$$a N^2 - b N + c = 0 \qquad \text{(ii)}$$

are real: they will be positive. Let us suppose first that they are unequal and call them α and β, $(\alpha > \beta)$. The equation (i′) will be

$$\frac{d N}{d t} = -a (N - \alpha) (N - \beta) N$$

or as well

$$-a d t = \frac{d N}{(N - \alpha) (N - \beta) N}$$

and integrated

$$e^{-c (\alpha - \beta) t} = \left(\frac{N}{N_0}\right)^{\alpha \cdot \beta} \left(\frac{N - \alpha}{N_0 - \alpha}\right)^{\beta} \left(\frac{N - \beta}{N_0 - \beta}\right)^{-\alpha}$$

N_0 is the value of N when $t = 0$ and we suppose $N_0 \pm 0, \alpha, \beta$.

We have further

$$\frac{d^2 N}{d t^2} = -a X \frac{d N}{d t}$$

where

$$X = 3 N^2 - 2 (\alpha + \beta) N + \alpha \beta,$$

But

$$X_{N=\alpha} > 0, X_{N=\beta} < 0, X_{N=0} > 0,$$

so the equation $X = 0$ has two positive roots: one γ lying between α and β, and the other δ smaller than β, i.e. we have

$$\alpha > \gamma > \beta > \delta > 0, \text{ and } \frac{d^2 N}{d t^2} = -3a (N - \gamma) (N - \delta) \frac{d N}{d t}.$$

9. I. If $N_0 > \alpha$, we have $\frac{d N}{d t} < 0$, $\frac{d^2 N}{d t^2} > 0$. N will decrease tending towards α and the curve $N(t)$ will always turn its concavity upwards. It has the straight line $N = \alpha$ for an asymptote (Fig. A).

II. If $\alpha > N_0 > \gamma$, we have $\frac{d N}{d t} > 0$, $\frac{d^2 N}{d t^2} < 0$. N will increase tending towards the value α and the curve will always turn its concavity downwards, its asymptote being the straight line $N = \alpha$ (Fig. B).

III. If $\gamma > N_0 > \beta$, we have $\frac{d N}{d t} > 0$, N will increase towards the α value and the curve $N(t)$ will have the straight line $N = \alpha$ as an

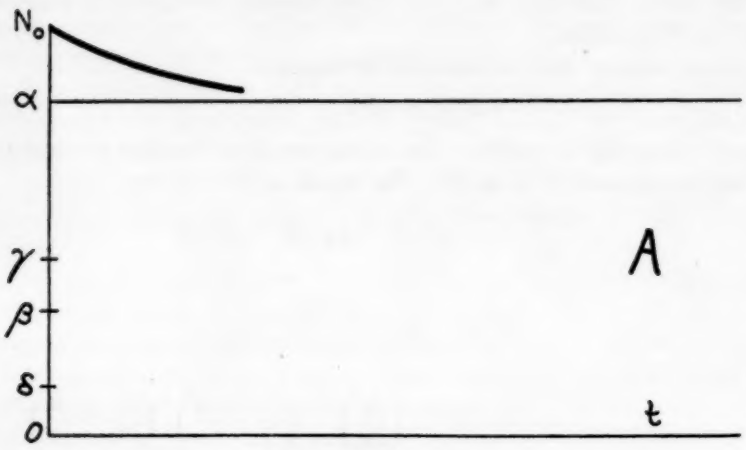

FIG. A

asymptote. When N shifts between N_o and γ we have $\frac{d^2 N}{d t^2} > 0$ and the curve $N(t)$ turns its concavity upwards; for $N = \gamma$, the curve presents an inflexion and as N shifts between γ and α, we have $\frac{d^2 N}{d t^2} < 0$, and the curve turns its convexity upwards. The curve $N(t)$ will have the same trend as the logistic curve of Verhulst-Pearl (Fig. C).

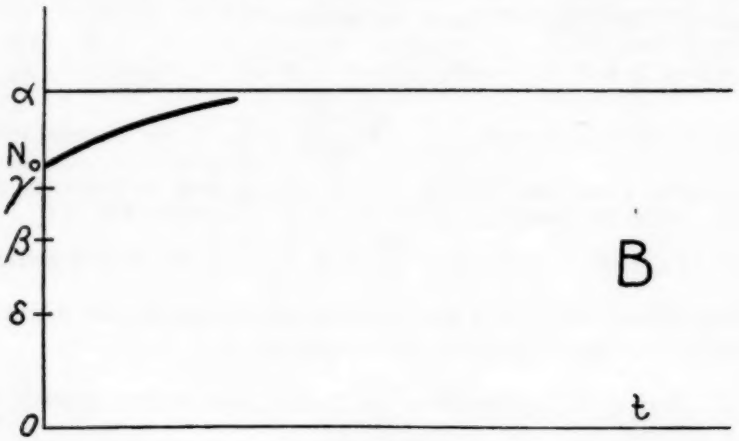

FIG. B

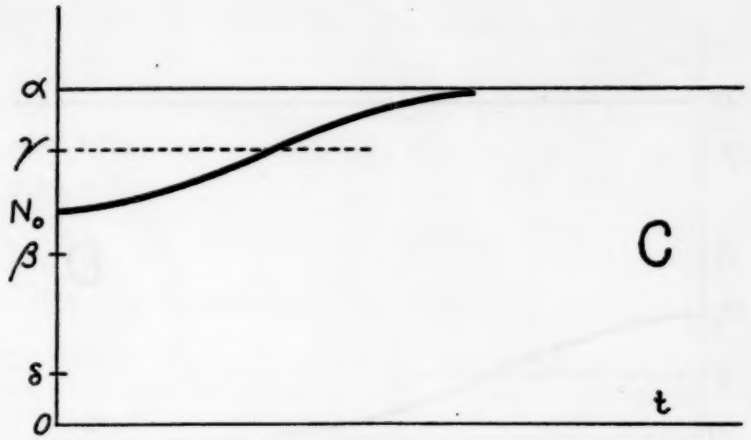

FIG. C

IV. If $\beta > N_0 > \delta$, we have $\frac{dN}{dt} < 0$, N will decrease tending towards 0 and the curve $N(t)$ will have the axis $N = 0$ as an asymptote. When N shifts between N_0 and δ, we shall have $\frac{d^2N}{dt^2} < 0$ and the curve $N(t)$ will turn its convexity upwards; for $N = \delta$, the curve will have an inflexion and when N shifts between δ and 0, $\frac{d^2N}{dt^2}$ will be > 0 and the curve will turn its concavity upwards (Fig. D). The species will decline and ultimately perish.

V. If $\delta > N_0$ we shall have $\frac{dN}{dt} < 0$; N will decrease and tend towards zero and the curve $N(t)$ will have as an asymptote the axis $N = 0$. We shall have $\frac{d^2N}{dt^2} > 0$ and the curve $N(t)$ will turn its concavity upwards (Fig. E). There will be an exhaustion in this case also.

10. The populations $N = \alpha$, and $N = \beta$ *are equilibrium populations* because they correspond to $\frac{dN}{dt} = 0$ and therefore to $N =$ constant. But for $N = \alpha$ *the equilibrium is stable*, while for $N = \beta$, *the equilibrium is unstable*, because if N departs a little from the α value, it

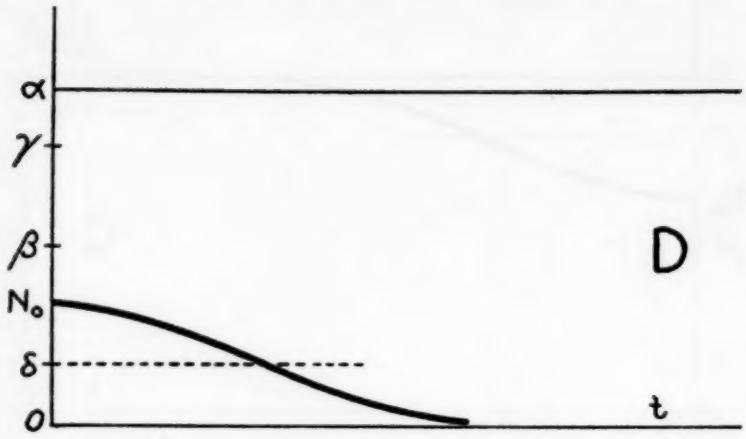

FIG. D

returns to a indefinitely, while if N departs from β, it gets away from β further and further as it tends towards a or zero.

11. Let us now consider the case of a double root equal to a. We shall then have

$$\frac{dN}{dt} = -a\,(a-N)^2\,N$$

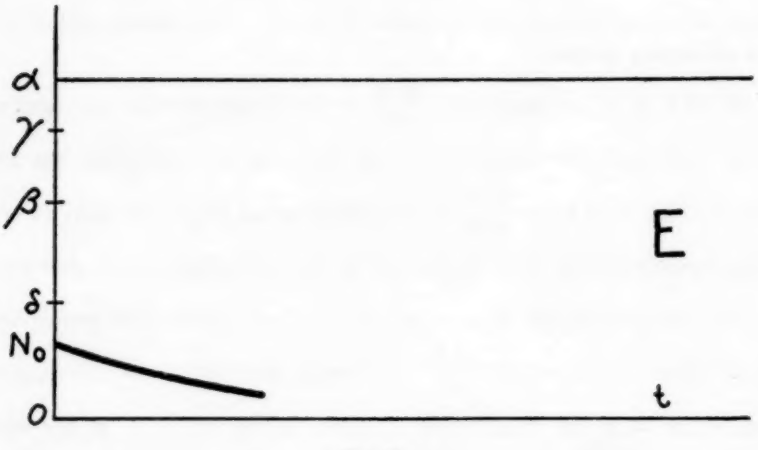

FIG. E

whence it results that N decreases. The integration gives

$$e^{-at} = e^{\frac{N - N_o}{a\,(a-N)\,(a-N_o)}} \cdot \left(\frac{N}{N_o}\,\frac{a-N_o}{a-N}\right)^{\frac{1}{a^2}}$$

where N_o is the initial value of N for $t = 0$.

We have then

$$\frac{d^2N}{dt^2} = -a\,(N-a)\,(3N-a)\,\frac{dN}{dt}.$$

I. If $N_o > a$, we shall have $\frac{dN}{dt} < 0$, and $\frac{d^2N}{dt^2} > 0$, therefore N will decrease tending indefinitely towards a. The straight line $N = a$ will be an asymptote of the curve $N(t)$ which will always turn its concavity upwards (Fig. F).

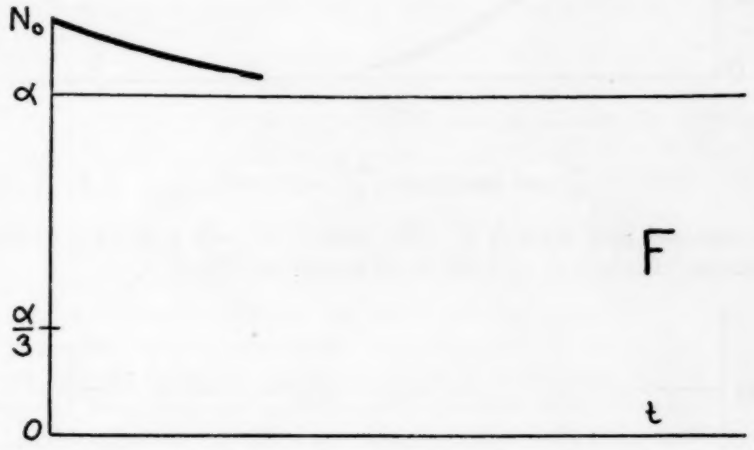

FIG. F

II. If $\frac{a}{3} < N_o < a$ we shall have $\frac{dN}{dt} < 0$; N will decrease, indefinitely tending towards 0. When N shifts between N_o and $\frac{a}{3}$ $\cdot \frac{d^2N}{dt^2}$ will be < 0 and the curve $N\ (t)$ will have its convexity turned upwards. For $N = \frac{a}{3}$, the curve $N(t)$ will have an inflexion and when N shifts

between $\frac{a}{3}$ and 0, $\frac{d^2N}{dt^2}$ will be > 0 and the curve will turn its concavity upwards. The axis $N = 0$ will be an asymptote (Fig. G).

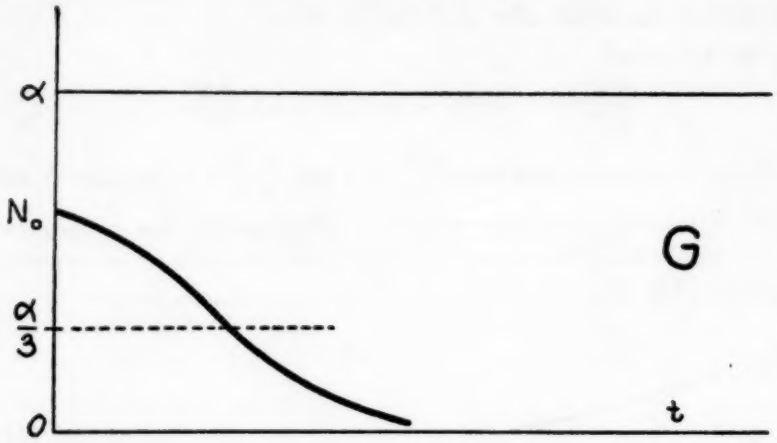

FIG. G

III. If $N_0 < \frac{a}{3}$, we shall have $\frac{dN}{dt} < 0$ and $\frac{d^2N}{dt^2} > 0$. N will decrease and tend towards 0. The curve $N(t)$ will turn its concavity upwards. The axis $N = 0$ will be an asymptote (Fig. H).

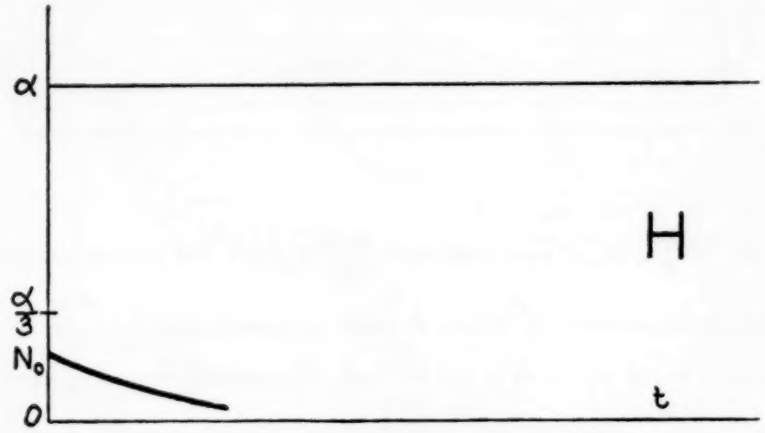

FIG. H

In the case of two roots equal to a, the population $N = a$ will be an equilibrium population. It will be stable for a disturbance which tends to increase it and unstable for one which tends to decrease it.

12. In the case when equation (ii) has imaginary roots, the integral of (i') will be

$$e^{-t} = \left(\frac{N^2 (a N_o^2 - b N_o + c)}{N_o^2 (a N^2 - b N + c)}\right)^{\frac{1}{2c}} e^{\frac{b}{c\sqrt{K}} \operatorname{arctg} \frac{2a(N - N_o)}{\sqrt{K}\left(1 + \frac{(2aN - b)(2aN_o - b)}{K}\right)}}$$

where N_o is the initial value of N for $t = 0$ and $K = 4ac - b^2 > 0$.

It immediately appears that $\frac{dN}{dt} < 0$ and N decreases and tends towards 0 for $t = \infty$. The curve $N(t)$ has the axis $N = 0$ as an asymptote and it is easy to distinguish the cases where there is an inflection or not. It is easy to recognize that if $b < 0$, N tends towards 0 for $t = \infty$.

In short:

*If the initial population is an equilibrium population, the population remains constant. In all other circumstances the species will disappear, except when (a) two equilibrium populations exist and when the initial amount of the population is greater than the stable equilibrium population or contained between the stable equilbrium population and the unstable equilibrium population. In both cases, the population tends towards the stable population and in the case where the population lies between the two equilbrium populations and is close enough to the unstable one, it can tend towards the stable population by changing the trend of its increase: (b) or when only one equilibrium population exists smaller than the initial population. In this case the population tends towards the equilibrium population.**

* I offer my best thanks to Miss Dr. H. Freda for having kindly controlled the formulas and the results of this paper and for correcting the proof sheets.

RELIABILITY OF DERMATOGLYPHICS IN TWIN DIAGNOSIS

BY JOHN W. MacARTHUR

Department of Biology, University of Toronto

INTRODUCTION

THE main purpose of this study was to develop a quantitative and wholly objective method of comparing finger and palm, toe and sole, prints or print formulae, so that the degree of likeness in the dermatoglyphics as a whole between two individuals or between the hands or feet of an individual may be more precisely stated (MacArthur, '36). No such really general procedure seems to have been attempted for either anthropological or genetic uses (but see Cummins, '30, '36; and Meyer-Heydenhagen, '34).

Most systems for distinguishing "identical" from "fraternal" twins or sets employ, along with other characters, some data from the prints; finger patterns are included among Stocks' ('30) criteria, and ridge counts among Rife's ('33) four quantitative characters. Even when dermatoglyphic data are weighted more heavily in the diagnosis especial emphasis is commonly laid on some one print character, or on the dermatoglyphics of one part; and the likeness of a pair has usually been merely "judged" or subjectively estimated from the formulae, an additional incalculable allowance being made both for details and impressions too subtle to be formulated, and for assumed partial or complete reversals of asymmetry (e.g. Newman, '30a, b, and '31a, b).

An improved measure of the reliability and limitations of the diagnosis of twin types by print characters alone, independently of all other characters, is obviously needed, since experts have rated the diagnostic value of the prints so variously. A few, like Wilder ('19), formerly considered them practically self-sufficient for a determination of the type of twinning. Among recent authors Meyer-Heydenhagen ('34) claims that point by point comparison of palm prints alone is a dependable means of separating one-egg and two-egg pairs in ninety percent of cases. Newman ('30a, b, '31a, b) also

especially emphasizes the value of both finger and palm prints. The majority of workers (e.g. Ganther and Rominger, '23; Komai, '28; Verschuer, '32; Siemens, '32) regard friction ridges as among the important diagnostic aids. Others, however, who have given the matter much attention, found the prints misleading and unreliable and concede them only a low diagnostic value (Lauterbach, '25; Reichle, '29; Cummins, '30; Rife, '33). To some extent the latter authors may have depended upon too few print characters, or trusted too implicitly, as we now suspect, in diagnoses made from the fetal membranes, but they have presented impressive evidence of marked dissimilarity in some undoubtedly identical pairs and especially in conjoined twins; and of close similarity in occasional pairs of unlike sex. Such divergent statements both of fact and of opinion clearly imply that the data have never been quantified.

The advantages of emphasizing dermatoglyphic features in diagnosis are that they comprise a large group of diverse characters requiring in common somewhat similar, though special methods of study; that they are so easily, accurately and permanently recorded; and that their formulated characters, like sex or blood groups, are fixed early and remain constant in all environmental conditions throughout life, and are thus always directly comparable in subjects of any race and of either sex at any age. In the latter respects particularly prints are superior to a great number of otherwise valuable diagnostic characters (color of eyes and hair, hair form, shape of ears, facial features, size, weight, proportions and dimensional measurements of parts, ossification times, intelligence, etc.) which are often disturbingly influenced by surroundings, sex or age, and concerning which comparisons are necessarily somewhat restricted to certain races, to adults, to children of the same age, or to pairs reared similarly. Siemen's recent comments ('32, page 212) stress the need for continued study of diagnostic methods: "Studien in dieser Richtung sind aber erforderlich, weil die Eiigkeitsdiagnose aus der Ähnlichkeit, so einfach sie auch bei Erwachsenen unser Breiten meist ist, bei Kleinkindern (Siemens, Rohlfs, Reichle) und bei dunklen Rassen (Siemens, Komai) recht schwierig sein kann, ein Mangel, der sich nur durch weitere Ähnlichkeitsstudien beheben lässt". Especially urgent and important are the problems of determining the twin type in very young children.

Again, twin diagnosis has been and still is oftenest attempted from the twin pair alone. Hence it seemed especially desirable as a second

objective of this study to extend the quantitative method to take in entire family units, both twinning and non-twinning families. This supplies a much-needed series of norms showing the average and range of resemblance in a number of friction ridge characters between parents and children, children among themselves, between mono-ovular pairs, and di-ovular pairs, and between left and right sides of individuals. Knowing the expected similarity among their relatives one may, it seems, arrive at a more dependable diagnosis of a particular twin pair.

A GENERAL METHOD OF COMPARING FINGER AND PALM PRINTS OR FORMULAE

The method proposed is a "similarity" method, measuring resemblance in many characters, but for the purpose in mind, taking all these characters from the dermatoglyphic record alone. Considered genetically the print characters are to be classed as a complex of indirectly inherited quantitative characters, which are plastic in the embryonic developmental period, are controlled by a large total number of factors (Bonnevie, '24, '31; Grüneberg, '28), and are at least partially independent of each other. The correlations are evidently highest between characters affecting the same part (finger pattern types, shapes, directions, and ridge counts; Bonnevie, '24, '31; Grüneberg '28; Cummins and Steggerda, '35) or between homologous parts of the hand and foot (as finger and toe patterns, M. Newman, '36; and ridge counts, unpublished observations). Correlations are apparently low or negligible between non-corresponding parts, such as fingers and palms, since the development of their friction ridges is conditioned by different sets of growth factors acting more or less locally (Bonnevie, '29; Cummins, '26, '29, '35).

Similarity methods work on the principle that parents will ordinarily be heterozygous for some of the many factors involved, and the possible combinations resulting from segregation and fertilization will be so numerous that children developing from separate eggs will seldom fail to differ in some of the print characters, while a really close resemblance amounting to concordance in all or most of these characters will be expected only when the genotype is duplicated as in identical twins. Theoretically, the greater the number of characters employed in the comparison the fewer become the cases where the children of a family will all be so nearly uniform that an identical pair can not be distinguished from their sibs. The greatest obstacle to be anticipated

is the wide variability of phenotypic expression of the same genotype, e.g. on the left and right sides of the same person, or in the two or more individuals arising by the division of a single zygote. In any event the sum of information yielded by all the various print characters combined certainly affords a far better estimate of genetic resemblance than will any of them taken separately.

TABLE 1

Finger and palm formulae of identical twin boys, A and B, and their older brothers, Sib¹ and Sib²

		FINGERS I	II	III	IV	V		PALMS				
A.	Left	W	W^r	W^s	U	U		11(10).	7.7(6).	11/5′	-t-A^s.	O.D.V.L/D.
		19-14	11-15	16-12	16-	14-0	(80)					
	Right	W	W	U	W^{ls}	U		11.	9.7.	4	-t-A^s.	O.V.L.D.
		16-21	17-19	13- 0	18- 4	15-0	(84)					
B.	Left	W	W^s	W^{lr}	U	U		11(10).	7.7(6).	11/5′	-t′-A^s/A^s.	O.D.O.L/D.
		15-17	20-14	1-18	20- 0	14-0	(89)					
	Right	W	W	U^w	W^{ls}	U		11.	9.7.	5′	-t-A^s.	O.V.L.D.
		19-16	17-15	6- 0	21- 2	15-0	(78)					
Sib^1	Left	W	W	W^r	W	U		9.	x.7.	3	-t′-A^s.	O.O.L.O.
		21-26	16-20	9- 8	23-24	22-0	(101)					
	Right	W	W^r	R	W	U		11.	x.7.	4	-t-A^s.	O.O.L.M.
		21-25	14-25	0-18	21-10	21-0	(110)					
Sib^2	Left	W	U	U	U^w	U		9.	0.5″.	5′	-t-L^r.	O.D.O.L.
		25-22	17- 0	13- 0	19- 0	15-0	(89)					
	Right	W	W^{ls}	U	W^r	U		11.	0.7.	5″	-t-L^r.	O.D.L.O.
		24-20	15- 7	8- 0	12-10	12-0	(71)					

The Procedure

The prints are read and formulated according to the standard scientific systems for fingers (Bonnevie, '24, '31; Geipel, '35) and palms (Cummins and others, '29; Geipel, '35), as illustrated in Table 1. It is highly desirable to indicate lesser differences whenever possible in the formulation (cf. Newman, '30a; M. Newman, '36, for digital patterns). Naturally, the accuracy of the method depends on the

correctness and completeness of the formulations from, or interpretations of, the prints.

Then, using the actual prints or the proper formulae derived from them, and comparing hands (a) bilaterally (left and right of the same person), (b) homolaterally (same side hands of a pair), and (c) heterolaterally (left of A with right of B, and right of A with left of B), the number of differences are noted in four respects, as in Table 2:

(1) The *ridge count* total for the five fingers of a hand, i.e. the hand quantitative value. The ridges may be counted directly as in Table 2 by Bonnevie's revised method ('29), or reduced to classes by Newman's ('30) or other methods. The observed difference in ridge counts is then expressed as a percentage of the average total ridge count of hands in general. The mean count in our sample is nearly 66 per hand, the right barely exceeding the left (66.3 : 65.8); this is approximately 1.7 times the value derived by Newman's classing scheme (about 39 per hand). It was discovered that variability in the ridge counts does not increase with the total count; rather, and somewhat unexpectedly, the differences in ridge number prove to be quite independent of their total number, so that at least as much difference is found when the hands (of one individual) or the individuals (of identical twin pairs) compared have few ridges as when they have many ridges.

(2) The *finger patterns.* The patterns of homologous digits are matched, a whole unit difference being allowed with one exception between any two of Galton's distinct patterns, e.g. between U and W, R, A, or a tented arch (T.A. or A^t); and a half difference for such lesser contrasts (see descriptions by M. Newman, '36) as in the different forms of whorls: W with W^u, W^{du}, W^{lr}; or W^r with W^{lr}; or in transitional types: A with A^t, or of U^a with U, or A. The number of differences per five fingers for hands compared or per ten fingers for individuals compared may be directly stated as a percentage of the total possible; necessarily, this is not quite the same as the method most used for ordinary quantitative characters (Dahlberg, '26; Verschuer, '28).

(3) The *palmar* digital and axial *triradii.* The courses of the palmar main lines (D, C, B, A) traced from the corresponding digital triradii to their numbered terminations on the margin of the palm are classed as wholly different when they reach definitely unlike non-adjacent marginal zones, as 11 vs. 9, or 7; 6 and 5′; and also in

TABLE 2

Showing the number of differences observed in the formulae of Table 1 (Wilson family) as regards:

(1) ridge counts, (2) finger patterns, (3) palm lines and (4) palm patterns; also (last column) the average percent difference in all respects combined

	LEFT-RIGHT DIFFERENCES				AVERAGE PERCENT DIFFERENCE
	(1)	(2)	(3)	(4)	
A.....	4	2½	3	2½	41.5
B.....	11	2½	3	3	46.6
Sib¹.....	9	1½	2	½	23.4
Sib².....	18	2	2½	2	39.2

	HOMOLATERAL DIFFERENCES								
	(1)		(2)		(3)		(4)		
	L	R	L	R	L	R	L	R	
A—B.....	9	6	1	½	½	½	1	0	11.7
A—Sib¹....	21	26	2	2	4	1	3	1½	42.8
—Sib²....	9	13	2½	1	3½	2	2	3	39.2
B—Sib¹....	12	32	2	2	3½	1½	3½	1½	43.2
—Sib²....	0	7	2½	1½	4	1½	1½	3	36.2
Sib¹ —Sib²....	12	39	3	2½	3	1½	4	2½	51.0

contrasts like 5′ and 11-5″, or 11 and 9-7; or 9 and 0. Half-unit differences are counted when the homologous lines end in adjacent positions, as 5′ and 5″, or 4; 3 and 3h, or h; 3^u and 3^p (Meyer-Heydenhagen, '34); 10 and 9, or 11; X and x, 9, 8, or 7; also when single and dual endings have one main number in common: 11 and 11 (10), or 11/7; 9-7 and 7. With the palm lines are grouped also the axial triradius or triradii, t being scored as different from 0, t″, or t′ t″, and as half different from t′, or t t′, as t′ is from t″, and the presence of t^u from its usual absence. In this respect also five items (the first five terms of the palm formula) are compared per hand, ten per individual.

(4) The *palm patterns*. The five palm pattern areas (ten per individual) are similarly treated. Hypothenar A^u is recorded as dif-

ferent from A^c, L^r, W, L^r/A^c, etc.; and interdigital or thenar L from W, D, d, V, M, or O in all combinations except as noted below. A half difference only is counted between hypothenar A^u and A^u/A^c; A^u and O; A^r and L^r, or T^r; L^r and L^{rw}; or between thenar and interdigital L and L/V, or L/O; L and l; D and d; O and V, or M; and between V and M.

Where practicable, additional comparisons are recommended and have been used with respect to (5) finger pattern shape indices, already in percentage form, (6) singleness or doubleness of finger patterns, (7) toe ridge counts, (8) toe patterns, and (9) sole lines and patterns. The last are preferably formulated more as are palms (cf. Lund, '33) than in code (Wilder and Wentworth, '32). Cummins ('30, '36) and Meyer-Heydenhagen ('34) have devised and used similarly several quantitative measurements and indices. The "hand lines" (Pöch, '25) though not strictly dermatoglyphic features, are usually available, and may well also be included. However, many of the above or other print characters are employed, the final step in the comparison is by calculation of the mean percentage difference, or likeness, from all of the separate criteria (Table 2).

It is probably undesirable to attempt distinctions more refined than units and half units. Even these are, like the print formulations themselves, somewhat arbitrary, and, like them also, tend to exaggerate or neglect some minor differences and to duplicate others. But these and other obvious criticisms are weakened when it is recalled that all of the comparisons are accorded exactly the same treatment throughout.

Applying the method to a family, the father is compared with the mother, each parent with each child, and all the children, single and multiple-born, with each other in all possible combinations two at a time (Table 2). On this basis triplets are treated as three pairs of twins, quadruplets as four pairs and quintuplets as ten pairs.

QUANTITATIVE RESULTS BY THIS METHOD

Left versus right hands of individuals

The scoring was first applied to the opposite hands of three groups of individuals, including: (a) 100 single born children of both sexes from non-twinning families, the number of families being perhaps still too few to form a wholly representative sample; (b) the 100 individuals diagnosed by various criteria as belonging to identical twin pairs, and

(c) the 100 diagnosed as fraternal twins of like sex, whose print formulations were published by Newman ('30a, '30b). This twin material was chosen because the numbers were fairly adequate, and the diagnoses and formulations had been made by another investigator, of course quite without anticipation of the present use of his data. Our own series of twins, including also ♂ ♀ pairs, is meanwhile being treated similarly to check and supplement these results. In this exploratory survey attention is directed first to discovering the major characteristics of the groups, and noting some of the chief theoretical implications of the observations.

TABLE 3

Average number of differences observed in: (1) ridge counts (quantitative value by Newman's method, whose total averaged about 78 per individual), (2) apical pattern types, per 10 fingers, (3) palm line terminations and axial triradii, 10 in all, and (4) palm patterns in 10 areas compared, and (last column) the average percent difference, equal weight being given columns (1) to (4)

HAND COMPARISON	(1) RIDGE COUNTS	(2) FINGER PATTERNS	(3) PALM LINES	(4) PALM PATTERNS	AVERAGE PERCENT DIFFERENCE
Bilateral					
100 identical twins	7.16	2.58	4.25	3.00	26.9
100 fraternal twins.....	8.14	2.61	3.64	3.28	26.5
100 single born	8.00	3.49	4.24	2.89	29.2
Homolateral					
50 prs. identical twins....	5.88	1.88	2.84	2.09	19.0
50 prs. fraternal twins....	22.94	4.38	4.15	3.65	37.9
62 prs. single sibs.....	22.52	4.77	4.54	3.69	39.8
65 prs. parent-child	26.30	5.01	4.84	4.39	44.1
15 prs. husband-wife	34.40	5.47	6.20	4.70	51.9
150 prs. random pairs	28.61	5.60	5.34	4.56	48.1
Heterolateral					
50 prs. identical twins....	6.86	2.51	4.04	2.96	26.0
50 prs. fraternal twins....	22.98	4.40	4.75	4.18	40.8
62 prs. single sibs.....	22.59	5.15	5.40	4.14	44.1
65 prs. parent-child	26.74	5.14	5.23	4.20	45.1
15 prs. husband-wife.....	34.20	5.57	6.57	4.80	53.5

It is obvious from the data (Table 3), as has been long known and emphasized, that individuals are commonly far from strictly symmetrical in any of their print characters. In fact the left and right sides differ on the average by about ten percent in their ridge counts, by twenty-six percent in finger patterns, some thirty percent in palm patterns, and as much as forty percent in line terminations and axial triradii. Altogether the opposite hands resemble each other in only about 72 percent of their formulated print characters. So much latitude in the phenotypic expression of a genotype on the two sides of the same body may be interpreted to be in part merely fortuitous—the unpredictable result of development in a plastic medium (Cummins, '26, '36), as seen most clearly in the ridge counts which average practically the same in both hands— and in part due also to the development by differential growth of a normal bilateral asymmetry, as in the finger and palm patterns and the palm lines. Such asymmetry is most conspicuously and consistently shown in the more distal and radial trend and the higher numerical values of the main lines of right hands.

In general the bilateral differences are equally marked in single-born and both types of twin-born individuals. It might appear that twins are more symmetrical than single persons in their finger patterns, but the discrepancy in this one respect may have resulted from the extensive sampling in a few families with unusually well developed finger patterns. The size of the left-right difference seems to be determined embryologically in each axiate individual, and to be independent of genetic factors, which make homolateral differences so unequal.

On the whole, the most important fact revealed by this comparison is that identical twin individuals as a group show fully as much bilateral asymmetry as do fraternal twins. This observation is hard to reconcile with the view (cf. Wilder, Newman, Reichle, Lauterbach) that a marked bilateral symmetry is very frequent in one-egg pairs, especially those with three hands similar and one different. It also speaks strongly against the familiar theory that in an identical pair one member represents the left, the other the right half of a divided zygote, and that evidence of such an origin persists in the prints to the definitive stage. The twinning mechanism must be of such a nature and so timed as to permit each member—at least of a fully separated pair—to develop the normal amount of contrast between the hands. Another comparison. that of both hands of one with each hand of the other, made on both separate and conjoined twins, would be of much interest in asymmetry problems.

Homolateral differences

Comparisons were made of left hand with left, and right with right both among relatives of several degrees and among unrelated pairs. These groups include the identical twins and fraternal twins above mentioned, ordinary single born children in all the 62 possible intersib pairings random as to sex, parents and their children (65 pairings), husbands and wives (15 couples), and 150 unrelated pairs taken randomized (50 ♂ ♂, 50 ♂ ♀, and 50 ♀ ♀) mainly from the same white American stock. The left side and right side differences proving always to be nearly the same, they are added together.

The importance of relationship is everywhere strikingly apparent in the averages, and to some extent in the ranges, of differences noted for each of the four characteristics studied. The averages will be discussed first.

Monozygotic twins. Each member of a so-called "identical twin" pair is in our experience invariably a unique individual in the details of the prints. The pairs studied were in no case duplicates or "doubles" in *all* of even the rather gross characters amenable to formulation. But they did show the expected very marked homolateral resemblance on all four counts (Table 3).

In quantitative value the mean difference approximated 7 percent (5.9 in 78, the equivalent of about 10 ridges in 132). This agrees with the high correlations ($r = 0.92$ to 0.95) reported in the same or similar materials (Newman, '30a; Bonnevie, '24, '31). The likeness would, of course, be even greater than that noted if the 10-finger (individual) ridge count totals were compared (Bonnevie, '31; Rife, '33), and considerably smaller if the corresponding single fingers are matched, as by Grüneberg ('28), who found the average finger difference for identical twins to be 1.58 ridges.

Of 10 finger patterns an average of 1.9 (19 percent) are different, which justifies Stocks' use of this criterion ('30) and also confirms Grüneberg's statement that one-egg pairs agree in 80.00 ± 2.03 percent of their finger patterns. In the palm line terminations and axial triradius positions there are 2.8 differences in 10 (28 percent), and in the palm patterns 2.1 differences in 10 (21 percent). This along with further evidence presented below indicates that the finger print characters, as here used, are superior in diagnostic value to the palm characters, and the ridge counts of fingers to their patterns.

The homolateral differences in identical pairs may be taken to indicate, besides error, the approximate extent of what may be called the genetic indeterminism (modifying effect of early intrauterine environment, etc.) in the inheritance of finger and palm print characters. Such indeterminism or fortuity is most marked in the palm line courses, and least evident in the more strictly "inherited" ridge counts.

In all four features identical twins show distinctly less contrast in same side hands (average 19 percent) than between their rights and lefts (27 percent). As might be expected (contrast Meyer-Heydenhagen, '34, p. 23) the absolute bilateral differences exceed the homolateral least for the normally nearly symmetrical ridge counts (3 percent), more for the slightly asymmetrical finger and palm patterns (7 percent and 9 percent respectively), and most for the highly asymmetrical palm line courses (14 percent). Since the opposite side difference as a whole is half again as large as the same side the diagnostic rules emphasized by Komai ('28) and Newman ('30) would be correct and valid in the general run of cases, though they both fail to pick out a considerable proportion of identical pairs.

The fraternal relationship. Fraternal twins alike in sex display on the average just about twice as much same side difference as do identical twins, and a third more than do their opposite sides. Practically the same (slightly greater) differences in all respects are found between pairs, random as to sex, of single born children of a sibship, as were noted between the fraternal twins, and indeed also between pairs, whether alike or unlike in sex, identified as fraternal from higher multiple birth series, triplets and quadruplets. Such disparities as were found between fraternals of the various sorts are slight and probably of no real or large significance, the deviation being less than half a standard error.

The ratio of identical homolateral : left-right : fraternal homolateral differences is close to 2 : 3 : 4. These relations are of first rate importance in distinguishing the twin types. But this method shows that the various criteria have very unequal merit and significance as items in a diagnosis because fraternal pairs differ 3.9 times as much as identical pairs in ridge counts, 2.3 times in finger patterns, 1.7 times in palm patterns, and less than 1.5 times in palm lines and axial triradii. Perhaps the values might justifiably be weighted accordingly.

Much practical help in determining the twin type in a particular pair isolated from the family is obtained by considering the homolateral dif-

ferences relative to the bilateral differences of any twins (taken as 100). In fraternal pairs the contrast between same and opposite side differences will be found conspicuous mainly in the finger prints, particularly in ridge counts, while in one-egg pairs the contrast is generally less, and should be looked for in the normally more asymmetrical apical patterns and palm characters, especially in the line terminations.

Differences	(1) *Ridge counts*	(2) *Finger patterns*	(3) *Palm lines*	(4) *Palm patterns*
Identical homolateral	82	73	67	70
Twin bilateral	100	100	100	100
Fraternal homolateral	282	168	114	111

The point merits some emphasis that a comparison of the relative amount of homolateral and bilateral difference in one and the same pair will commonly, though not invariably distinguish the twin type. For instance, in the 50 identical pairs, the homolateral difference was less than the bilateral in 42, and exceeded it in 8 cases. In the fraternal twin pairs, the same-side was less than the left-right difference in 6, equal to it in 2, and greater in 42 instances. This means, of course, that the trends regularly observed in massed data are by no means always followed closely in particular cases. Even in pairs of single sibs the left-right occasionally exceed the same-side differences; this is frequent in some families.

The parental-filial relationship. Parents compared with their offspring, either single or multiple born, exhibit slightly but consistently greater differences in all four respects than do the offspring taken *inter se.* This fact is already familiar from study of other characters (e.g. Lauterbach, '25), and may indicate that some of the genes controlling the print characters will prove to be dominant-recessive rather than blending in their genetic behavior.

Random pairs. The 150 thoroughly randomized pairings of unrelated individuals (from the twin pairs) show much the same degree of difference as was found in the 15 married couples. These matings were not noticeably assortative. Most random pairs are quite unlike; a few may by chance be quite similar. The dissimilarity was less marked in ridge counts than in the other more variable characters; the common average difference rises to about 50 percent, which is 2.6 times the

mean difference between monozygotic pairs. It may possibly be significant that random male-male pairs showed a definitely greater contrast in their ridge counts (41 percent) than did female-female pairs (30 percent), the male-female pairs being intermediate (36 percent).

Heterolateral differences

In the group of identical twins the heterolateral differences resemble closely the bilateral ones, but were all slightly less than the corresponding left-right values (Meyer-Heydenhagen, '34, p. 23). Considered from one point of view this may indicate mirror imaging in some of the identical pairs. In fact there are seven pairs in Newman's series (nos. 9, 96, 94, 78, 79, 15, and 18) where the asymmetries are definitely complementary; in this selected subgroup the heterolateral differences average 19.5 percent and the homolateral 25.7 percent the reverse of the usual relation. The remaining 43 pairs differ by 17.8 percent homolaterally and 27.0 percent heterolaterally.

In the fraternal twins and all the remaining groups the mean heterolateral differences definitely exceed both the bilateral and the homolateral.

The quantitative relations of the three comparisons of the twin materials are well shown in a tabular form:

TABLE 4

Mean percent differences in print characters in hands of twins

	HOMOLATERAL	HETEROLATERAL	BILATERAL
Identical	18.9	26.0	26.9
Fraternal	37.9	40.8	26.5

These relations constitute a compact summary of the average differences in dermatoglyphics characteristic of the twin types (assuming that a third type does not occur). To this model conform 42 (84 percent) of the fraternal pairs, and 33 (66 percent) of the identical pairs. An additional 9 pairs (18 percent) of the identicals show asymmetry reversal, as usually interpreted. In short in 84 percent of

the fraternals the homolateral and heterolateral differences exceed the bilateral, while in 84 percent of identicals either the bilateral and heterolateral exceed the homolateral or the bilateral and homolateral exceed the heterolateral difference. Thus, if these series are typical of twins, the conclusion seems permissable that the suggested routine study of dermatoglyphic features will correctly diagnose 84 percent of the pairs. The rules still require test in twin series diagnosed originally entirely without reference to print characters.

It is only fair to add, as indicating the diagnostic limitations of this method, that an impartial application of the same criteria would pick as fraternal or doubtful the remaining pairs called identical (nos. 33, 44, 17, 41, 60, and probably 53, 7, and 27—all of which are listed by Newman as among the less similar pairs). Among the fraternal pairs, nos. 65, 39, 45, 84, 20, and 48 would have to be classed as identical; and no. 22, and possibly also 47, as identical with reversed asymmetry.

That such exceptions to the general rule are not to be explained simply as so many errors in diagnosis is shown in the ampler data from entire families. Single sib pairs, which are unquestionably fraternal, and the parent-child comparisons supply the same sort of irregularities as do the twins called fraternal, and with about the same percentage frequency (Table 5).

Two points are apparent; that the line of demarcation separating identical twins from all other groups is real but not sharp, and that

TABLE 5

Percentage frequencies of pairs showing differences in the order:

	BILATERAL & HETEROLATERAL GREATER THAN HOMOLATERAL	BILATERAL & HOMOLATERAL GREATER THAN HETEROLATERAL	HOMOLATERAL & HETEROLATERAL GREATER THAN BILATERAL	OTHER RELATIONS BETWEEN DIFFERENCES
Identical twins ...	66	18	8	8
Fraternal twins ..	12	2	80	6
Single sib pairs...	19	0	76	5
Parent-child	5	2	86	8
Husband-wife	7	0	80	13

the compensatory asymmetries or mirror imagings, as in Table 5, second column, are about 18 times as frequent in identical pairs as in other groups, in which they are seldom found.

Considered in a purely descriptive sense the data thus substantiate "asymmetry reversal", but this term has come to connote commitment to special theories of twinning; an alternative interpretation of mirror imaging is possibly preferable in view of the relations shown in Table 4. Briefly, in identical twins the bilateral and heterolateral differences average only 7-8 percent greater than the homolateral, but in fraternals the bilateral differences are less than the homolateral and heterolateral by 11-14 percent; all of the differences vary greatly and rather fortuitously; and therefore irregular or atypical relations will be encountered oftener among identicals than among fraternals or other groups. For example, asymmetry reversal in an identical pair requires only sufficient fluctuation of homolateral and heterolateral differences (see Table 6) to overcome and reverse the 7 percent difference between them, the bilateral values remaining average. The calculated expectation of this occurrence is 20 percent and the observed frequency 18 percent. In fraternal twins or sib pairs, however, mirror imaging necessitates that the usual relations be disturbed in two ways simultaneously: (1) that bilateral and heterolateral fluctuations be extreme (and therefore rare) enough to reverse the large 14 percent differences between them, and (2) at the same time that homolateral and heterolateral values vary enough to reverse a 3 percent difference; the calculated coincidence expected here is 1.4 percent (observed 0-2 percent); similarly for the cases with three hands alike and one odd. In general the various observed combinations of relations (Table 5) are largely explainable on the basis of random coincidence.

Range and distribution of the differences

Even identical twins vary greatly from pair to pair in the amount of difference they show. For the 50 identical pairs the same side differences ranged from 2.8 to 34.5 percent; for the fraternal twins from 22.3 to 60.5 percent; and for the 165 unrelated pairs from 22.4 to 88.7 percent. The heterolateral differences spread even more. The 275 left-right differences likewise varied widely between 1.3 and 59.6 percent; since only two hands are here compared, the fluctuation is extreme. The arrays are given in Table 6.

TABLE 6

Distributions showing the frequency of observed mean percent differences (classes 0-3, 3+ to 6, etc.) homolaterally and heterolaterally between pairs of individuals, bilaterally between hands of one individual

DIFFERENCE	PERCENT																										
	0	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63	66	69	72	75	78
Bilateral																											
Identical twins	2	2	2	3	4	7	16	9	4	6	15	8	5	7	7	1	1	..	..	1	..	..	..	..	..	..	..
Fraternal twins	.	.	3	6	9	3	8	13	14	4	18	9	7	5	3	1	1	..	..	..	..	..	..	..	..	..	..
Single born	.	.	5	2	3	5	6	14	8	8	11	13	6	6	5	4	2	1	1	..	..	..	..	..	..	..	..
Homolateral																											
Identical twins	1	3	2	7	7	4	6	3	7	5	1	4	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Fraternal twins (like sex)	.	.	.	.	..	..	..	1	5	2	5	7	5	4	8	1	4	3	3	2	..	..	..	..	..	..	..
Single sibs (random sex)	.	.	.	.	..	1	1	1	3	8	3	9	8	5	3	4	6	3	2	1	3	1	..	..	..	..	..
Parent-child	.	.	.	1	..	1	..	1	2	1	4	8	5	5	8	7	4	4	2	6	3	2	1	..	..	..	..
Husband-wife	.	.	.	.	..	..	..	..	..	..	2	1	..	2	1	..	1	2	1	2	1	..	..	1	..	..	1
Male-male random	.	.	.	.	..	..	..	..	..	..	2	2	3	5	4	11	5	3	1	6	3	3	1	..	..	1	..
Male-female random	.	.	.	.	..	..	..	2	1	2	3	3	3	3	3	2	8	6	5	..	..	5	1	..	1	2	..
Female-female random	.	.	.	.	..	..	..	1	..	4	2	1	5	3	6	4	7	7	2	1	2	2	1	2	..	..	..
Heterolateral																											
Identical twins	.	1	.	1	2	6	3	5	9	9	6	2	4	1	1	..	..	..	..	..	..	..	..	..	..	..	..
Fraternal twins	.	.	.	.	..	..	..	3	..	2	4	4	10	5	5	7	5	2	..	2	..	1	..	..	..	..	..
Single sibs	.	.	.	.	..	..	..	1	4	3	2	8	4	4	6	11	2	5	2	4	..	2	4	..	..	..	..
Parent-child	.	.	.	.	..	1	1	..	2	2	3	4	9	7	5	8	5	3	4	4	1	3	1	1	..	..	1

The characteristic features of the distributions are the somewhat wider ranging and flatter curves for the fraternal, parent-child, and random pairs, indicating a genetic diversity in these which is quite absent in the one-egg pairs. If the distributions of homolateral differences for the identical and fraternal twin pairs be thrown together, there is no smooth overlapping of the curves, and allowing for erratic fluctuations the modes at least remain recognizable.

Though the averages of the mean percent homolateral differences in the several relationship groups are distinct enough for practical use, the extremes of the groups so much encroach on one another that there is a zone where in fact all distributions overlap. Clearly no *absolute* values or limits can be set that will automatically separate the two types of twins into distinct categories. The twin pairs with less than 21 percent difference in same side hands were identicals, though such approaches toward dermatoglyphic "doubles" are, at least theoretically, to be expected rarely among fraternal or random pairs. Since only 5 identical pairs had more and only 8 fraternal pairs less than 30 percent homolateral difference, the following simple rule is suggested: *If a pair has no more than 30 percent homolateral difference in hands the probability is 84 percent that they are monozygotic; if they have more than 30 percent homolateral difference the probability is 90 percent that they are dizygotic.*

TWINS COMPARED WITH THEIR OWN PARENTS AND SIBS

It has sometimes escaped notice that the severest and most practical test of such a diagnostic rule is not whether it will serve to distinguish between identical twins of one family and fraternal twins from some other family, but whether it will separate efficiently and decisively an identical pair from their own sibs, in whom the family likeness is evident. In an actual case the twin or multiple birth set may usually be compared with their parents and frequently also with older or younger sibs, and all of these members of the family with each other. Some sibships and families are found to be highly variable, and others almost monotonously uniform in prints, but the total range of variation within a family is ordinarily much less than in a large population, because the sample is smaller and the parents very seldom both segregate for the maximum number of genes controlling the various print characters.

Comparisons being confined to the immediate family, twins judged identical by their resemblance in facial features, etc. have so far in-

variably shown the lowest homolateral difference of any pair in the entire family, and thus stand apart from the more or less continuous distribution of homolateral differences of the other pairs of the family. Fraternal twins, however, are as unlike as the other sib pairings and their difference falls among the inter-sib and parent-child values in general and within the same more or less continuous distribution. For instance in the Smith family, consisting of the parents, twin girls and 11 other children, the twin difference was small (5.5 percent), as in monozygotics, while all the 77 remaining inter-sib and the 26 parent-child differences were relatively large and ranged continuously between 22 and 78 percent. In all cases the rule has held that the homolateral difference is comparatively small in identical pairs. This substantially summarizes the results from the first 15 twinning family groups. It is still too early to say what residue of cases will prove too difficult to diagnose under these conditions.

Employing the family unit seems to offer the same promise in twin diagnosis from prints, as it does from other characters. In general it is recommended as promising aid in the solution of various problems of twinning and of the inheritance of print characters that especial attention be directed to collecting dermatoglyphic records from entire families, rather than from odd individuals, or isolated twin pairs or multiple birth sets.

MULTIPLE BIRTH SETS ANALYZED AS PAIRS

Triplet and quadruplet sets are analyzed successfully by the same treatment. The Johnson triplets (Lund, '33) are easily demonstrated as monozygotic, the three intra-triplet pairings, XY, XZ and YZ, having very definitely smaller homolateral differences in finger, palm and sole prints than any of the 51 other pairs in the whole large family. In each of two other newly studied monozygotic triplet sets the identical pair differences are also the three lowest in the family, but the distributions are not so sharply discontinuous; whether the separation in such cases will prove to be made more distinct by the inclusion of additional dermatoglyphic criteria is still to be determined. The Morlok quadruplet girls have no other sisters or brothers, and the parents' prints were not obtained; but the six pairings within the set group together in a practically continuous distribution with a modal value like that for identical twins (see MacArthur and MacArthur, '37; and Table 7).

Except in one case (C-D), the bilateral exceeds the homolateral difference.

In the higher multiple birth series the mutual relations of pairs within the set become of increasing diagnostic significance. The dizygotic triplet sets show *one* pairing identical (i.e. with low homolateral difference and a greater bilateral difference) and *both* the others fraternal and scattered somewhere among sib differences generally. The Keys quadruplets, finger and palm printed by Dr. N. Ford, are quite convincingly differentiated as trizygotic; Roberta (A) and Mona (B) are as similar as an identical pair, but each shows a fraternal difference from both Mary (C) and Leota (D) as these do from each other (Table 7). The same-side difference exceeds the left-right in the fraternal pairings, but not in the identical pair.

Identical pairs show equal resemblance (18-21 percent homolateral difference) whether they are born as twins or belong to triplet or quadruplet sets.

TABLE 7

Average percent differences in the six possible pairings among the Morlok (monozygotic) and the Keys (trizygotic) quadruplets

(Identical pairs in italics)

	MORLOK			KEYS		
	Homolateral	Heterolateral	Bilateral	Homolateral	Heterolateral	Bilateral
A-B	*21.2*	27.9	30.1	*11.6*	24.8	32.2
A-C	*21.3*	25.8	30.2	31.2	24.9	23.2
A-D	*22.1*	38.3	34.4	45.4	41.6	17.2
B-C	*12.7*	25.1	22.0	42.8	37.8	27.2
B-D	*21.0*	26.4	26.3	45.6	41.4	21.3
C-D	*29.2*	31.5	26.3	33.0	35.5	12.2
Average						
(identical)	21.25	29.2	28.2	11.60	24.8	32.2
(fraternal)	...	...	...	39.64	36.25	20.2

THE VALIDITY OF DIAGNOSIS OF TWIN TYPE BY PRINT CHARACTERS

If the several rules for separating monozygotic and dizygotic twins by dermatoglyphic criteria are brought together it will be seen that they are really closely related and in good agreement. Taking a 30 percent homolateral difference as the dividing line the indicated probability of a correct diagnosis is from 84 to 90 percent (p. 16); when the twin pair is checked against their own sibs and parents the probability remains high (p. 17). Making the diagnosis according to whether the homolateral difference is less (identical) or greater (fraternal) than the bilateral (p. 13) gives a rule also applying in 84 percent of the pairs. The more complicated procedure involving comparison of the relative sizes of the homolateral, heterolateral and bilateral differences (p. 15) gives equal, but no greater, accuracy, even if the cases with compensating asymmetry (mirror imaging) are admitted as mainly monozygotic. It is to be emphasized that each of these estimates has been determined on the basis of comparisons of the hands alone, and of only the four regularly formulated characters from these hands. It would seem reasonable to expect greater accuracy and more selectivity if more print characters were included.

ANALYSIS OF THE VARIANCE

The heterolateral differences naturally should exceed both the homolateral and bilateral, when a pair differs genetically. Heterolateral differences exhibit in a sense the combined effect of all the factors, genetic and epigenetic, which tend to produce unlike prints. These factors include, besides error: (1) the indeterminism influence (environmental, etc.) acting generally, often simulating somatic segregation, and best measured quantitatively by the homolateral difference between genotypic duplicates; and superposed upon this, both (2) the asymmetry mechanism acting bilaterally in the development of the embryonic axes, and (3) the genetic factors causing additional differences between individuals of unlike genotype.

The proportionate influence of these factors was determined statistically from the relative sizes of the standard deviations calculated from zero (Dahlberg, '26 p. 217), of the difference distributions in the series of relationship groups. The considerable rôle of environment (including error, etc.) in causing dermatoglyphic variation is indicated by the standard deviation ($\sigma = 20.8 \pm 2.08$ percent) for the distribution

of homolateral differences in identical pairs, where hereditary differences are considered absent. The amount for which the asymmetry mechanism is responsible may be calculated by contrasting either the homolateral and bilateral differences in identicals ($\sigma = 19.1 \pm 1.91$ percent), or the homolateral and heterolateral differences in fraternals ($\sigma = 15.3 \pm 1.53$ percent). Finally the large effect of varying a part of the genetic factors, as in fraternal twins, is shown by comparing either the identical homolateral and the fraternal homolateral distributions ($\sigma = 32.7 \pm 3.27$ percent) or the fraternal heterolateral and bilateral distributions ($\sigma = 31.4 \pm 3.14$ percent). For random pairs the hereditary influence is still greater accounting for differences corresponding to the standard deviation of approximately 45 percent. The same relative influence (heredity > environment and error > bilateral symmetry), and the marked significance of each, are demonstrable with an adaptation of Fisher's method of analysis of variance. Obviously such determinations may be made for whatever slight sex influence there may be, and also for each of the dermatoglyphic characteristics separately. These points will be dealt with elsewhere.

SUMMARY AND CONCLUSIONS

The features usually formulated from hand or foot prints are especially valuable as diagnostic characters go, since they are universally comparable regardless of race, sex, age, or surroundings.

A wholly objective method is proposed and illustrated for comparing finger and hand (and toe and sole) prints or formulae so that the differences between hands or individuals in their dermatoglyphic characters may be viewed collectively and stated quantitatively as a percentage.

Data from an exploratory survey by this method show the averages and ranges of these differences in ridge counts, finger patterns, palm line terminations and axial triradii, and palm patterns, between left and right hands; and also the differences homolaterally and heterolaterally between the hands of pairs of identical twins, fraternal twins of like sex, single sibs, parents and children, and unrelated persons. The mean of the separate percentage differences in the several print characters is taken as the measure of similarity. The findings agree with genetic expectations and with so many published data that the method appears reliable.

The identical twins were in no case "doubles" in even the rather gross formulated characters of the finger and palm prints; in details each individual was unique.

Identical twin individuals show as much bilateral asymmetry (about 27 percent difference) in their print characters as do fraternals; and twins in general probably as much as single born. This observation is inconsistent with certain theories of twinning.

The homolateral difference increases as genetic relationship of the pair decreases, averaging 19 percent in identicals, 38-40 percent in fraternals, 44 percent between parents and children, and 48-52 percent between unrelated individuals.

The corresponding heterolateral differences are larger, being approximately 26 percent in identical pairs, 41-44 percent in fraternal twins or sibs, 45 percent between parent and child, and 53 percent between random pairs.

Analysis of variance in the series studied shows that the finger and palm print differences are more powerfully influenced by genetic than by epigenetic factors. Among the latter the unanalyzed influences (error, early intrauterine environment, etc.) are of greater importance than the mechanism producing bilateral asymmetry.

The probability of a correct diagnosis of twin type by the suggested routine comparisons of finger and palm prints is indicated by the following practical rules:

(1) The homolateral difference was less than 30 percent in 90 percent of the identical pairs and greater than 30 percent in 84 percent of the fraternal twin pairs of like sex.

(2) In 84 percent of cases, the homolateral difference was less than the bilateral in identical, and greater than the bilateral in fraternal twins.

(3) In 84 percent of fraternal pairs both homolateral and heterolateral differences exceed the bilateral, while in the same proportion of identical pairs the bilateral and heterolateral exceed the homolateral, or (in case of "asymmetry reversal") the bilateral and homolateral exceed the heterolateral difference.

In mixed sets of triplets or quadruplets the same rules hold and the identical pairs within the set are similarly separable from the fraternals,.

Employing additional print characters makes the separation increasingly selective.

It is suggested that the much more frequent occurrence of mirror imaging or asymmetry reversal observed in identical twins does not necessarily require adherence to the theory of twinning the terms imply, but may be largely explained as the result to be expected from the chance fluctuations of differences.

When the comparisons are made in all the possible pair combinations among the members of a single family containing identical twins or triplets the homolateral differences fall into two quite separate groups; those for monozygotic pairs stand distinct from the range of distribution of paternal or parent-child values, and the diagnosis of a pair is seldom left in doubt.

This quantitative method appears to offer distinct promise as an improved means of distinguishing identical pairs or sets, when the print characters alone are available. Further test is recommended on print data collected from entire families containing twins or multiple births, and on twin series diagnosed entirely without the aid of dermatoglyphics.*

LITERATURE CITED

BONNEVIE, K., 1931. Zur Genetik des quantitativen Wertes der Papillarmuster. *Zeits. f. ind. Abst.- und Vererbungsl.*, 59: 1-60.

CUMMINS, H., 1926. Ontogenetic factors which condition ridge direction. *Amer. J. Anat.*, 38: 89-151.

————. 1929. The topographic history of the volar pads (walking pads: Tastballen) in the human embryo. *Contr. Embryol. Carn. Inst., Washington*, 20: 103-136.

————. 1930. Dermatoglyphics in twins of known chorionic history, with reference to diagnosis of the twin varieties. *Anat. Rec.*, 46: 179-198.

————. 1935. Morphology of the palmer hypothenar dermatoglyphics in man. HUMAN BIOLOGY, 7: 1-23.

————. 1936. Finger prints in "Siamese" twins. *Eugen. News*, 21: 89-95.

CUMMINS, H., *et al.*, 1929. Revised methods of interpreting and formulating palmar dermatoglyphics. *Am. J. Phys. Anthrop.*, 12: 415-473.

CUMMINS, H. and STEGGERDA, M., 1935. Finger prints in a Dutch family series. *Am. J. Phys. Anthrop.*, 20: 19-41.

GANTHER, R. and ROMINGER, E., 1923. Über die Bedeutung des Hautenleistenbildes für die Zwillungsforschung. *Zeitsch. Kinderheilk.*, 36: 212-220.

GEIPEL, G., 1935. Anleitung zur erbbiologischen Beurteilung der Finger-und Handleisten. J. F. Lehmanns, *München*.

* Postscript.

(1) Just such a twin series has been diagnosed by dermatoglyphics alone with even more successes than claimed above (see Rife in a forthcoming number of *Journal of Heredity*).

(2) The method has since been used with the Dionne Quintuplets (MacArthur and Ford), 1937, *A Biological Study of the Dionne Quintuplets—an Identical Set* (University of Toronto Press).

(3) The author is finding additional features of high diagnostic value in the ridges of the neglected basal phalanges of the fingers.

GRÜNEBERG, H., 1928. Die Vererbung der menschlichen Tastfiguren. *Zeits. f. ind. Abst.- und Vererbungsl.*, 46: 285-310.

KOMAI, T., 1928. Criteria for distinguishing identical and fraternal twins. *Quart. Rev. Biol.* 3: 408-418.

LAUTERBACH, C. E., 1925. Studies in twin resemblance. *Genetics*, 10: 525-568.

LUND, S. E. T., 1933. A psycho-biological study of a set of identical girl triplets. HUMAN BIOLOGY, 5: 1-34.

MACARTHUR, J. W., 1936. A measure of similarity in finger and palm prints aiding diagnosis of identical and fraternal twins. *Royal Soc. of Canada*, Abstracts p. 52.

MACARTHUR, J. W. and MACARTHUR, O. T., 1937. Finger, palm and sole prints of monozygotic quadruplets. *J. Hered.* 28: 147-153.

MEYER-HEYDENHAGEN, G., 1934. Die palmaren Hautleisten bei Zwillingen. *Z. Morphol. Anthrop.* 33: 1-42.

NEWMAN, H. H., 1930. (a) The finger prints of twins. *J. Genet.* 23: 415-446.
(b) Palmar dermatoglyphics of twins. *Amer. J. Phs. Anthrop.* 14: 331-378.

————. 1931. (a) Palm print patterns in twins. *J. Hered.* 22: 40-49.
(b) Differences between conjoined twins. *J. Hered.* 22: 201-215.

————. 1934. Dermatoglyphics and the problem of handedness. *Am. J. Anat.* 60: 277-322.

NEWMAN, MARSHALL, 1936. A comparative study of finger prints and toe prints. HUMAN BIOLOGY, 8: 531-552.

PÖCH, H., 1925. Über Handlinien. *Mitt. Anthrop. Ges. Wien.* 55: 133-159.

REICHLE, H. S., 1929. The diagnosis of the type of twinning. I. Dermatoglyphics. *Biol. Bull.* 56: 164-176.

RIFE, D. C., 1933. Genetic studies in monozygotic twins. *J. Hered.* 24 : 339, 407, 443.

SIEMENS, H. W., 1932. Die allgemeinen Ergebnisse der menschlichen Mehrlingsforschung. *Zeits. f. ind. Abst.- und Vererbungsl.*, 61: 208-222.

STOCKS, P., 1930. A biometric investigation of twins and their brothers and sisters. *Annals of Eugenics* 4: 49-108.

VERSCHUER, O. V., 1932. Die biologischen Grundlagen der menschlichen Mehrlingsforschung. *Zeits. f. ind. Abst.- und Vererbungsl.*, 61: 147-205.

WILDER, H. H., 1919. Physical correspondence in two sets of duplicate twins. *J. Hered.* 10: 410-420.

WILDER, H. H., and WENTWORTH, B., 1932. Personal Identification. *Chicago*: T. G. Cooke.

VARIATION IN THE SEX RATIO AT BIRTH IN THE UNITED STATES[1]

BY ANTONIO CIOCCO

INCLUDED with death and taxation, among the certain things to expect in a variable world is that more boys than girls are born every year in any sufficiently large population group. This fact has been given statistical recognition since the publication of Graunt's observations, and by Süssmilch it was considered an illustration of a "divine order".

The numerical superiority of the males at birth, while always evident, varies in degree from period to period and place to place. The existence of this variation has spurred a host of population students to investigate its causes, in the hope also of obtaining a hint regarding the factors involved in sex determination. From the standpoint of general biology, the problem of sex determination was regarded as almost completely solved in the flurry of discoveries which marked the beginning of modern genetic investigations. Until a few years ago, research in genetics had apparently shown that the mechanism of sex production is rather simple since the determiners for sex are present in one particular pair of chromosomes, therefore called the sex chromosomes. The constitution of these chromosomes differs in the two sexes and in gametogenesis the gonads of one sex (the male in man) produce two type of gametes while the gonads of the other sex produce only one type. Random combination of the male and female gametes at fertilization would then have as a result, with equal probability, either of two kinds of zygotes, a male or a female. Further research in lower animals has shown that the process of sex determination is not quite as simple as this. It has been demonstrated, for example, that the sex of the zygote is not determined by the constitution of the sex chromosomes alone, but also by that of the autosomal chromosomes (Bridges, 1932). In addition, observations have been reported to indicate that in spite of the genetic

[1] From the Department of Biology of the School of Hygiene and Public Health, Johns Hopkins University, Baltimore, Maryland.

constitution, pathologic changes can alter the established sex as in Crew's (1923) domestic fowl which was transformed from a broody hen to a potent rooster. Environmental factors such as temperature also can effect the sex of an animal notwithstanding the genetic constitution. This is illustrated by the series of experiments made by Witschi (1934) who was able to reverse the sex of female tadpoles after the formation of the ovaries.

With regard to man it must be assumed that the mechanism of sex determination is just as complex as it appears in other animals. However, no direct evidence can be presented because for man no information is available regarding the proportion of the sexes conceived. Consequently, in human biology this problem has been approached indirectly from the study of the variation of the sex ratio at birth. So far, this approach has been successful only in demonstrating that the variation of the birth sex ratio does not admit of any simple explanation. Decades of effort at solving this problem have resulted in theories galore. Numerous observations have been recorded pro and con on any particular theory and at present a mass of contradictory data has been accumulated through which a consistent thread is barely seen.

To the published data this paper adds those derived from the official vital statistics of the United States, the main purpose being to arrive at a more definite conclusion regarding the demographic factors supposedly related to the fluctuations of the sex ratio.

TREND OF THE SEX RATIO IN THE U. S.

In the twenty years from 1915 to 1934 the sex ratio— number of live male births per 1000 live female births—in the Birth Registration Area has varied from 1053.2 to 1060.4 (Table 1). The unweighted mean for the twenty-year period is 1056.8 ± .4.* From 1931 on there has been a slight decline; for the last four years, the mean ratio is 1054.6 compared with 1057.4 for the preceding 16 years. However, this difference, relative to its standard error, does not seem significant.

The slight declining trend observed in the annual birth sex ratio for all the Birth Registration Areas is not evident for the white population of the states which comprised the original Birth Registration Area. For these states, taken together, the annual ratio has oscillated from 1051.0

* Unless otherwise stated, the standard error is the measure of dispersion used.

TABLE 1

Annual sex ratio of births in U.S.B.R.A. and in white population of original (1915) U.S.B.R.A.

YEAR	ALL BIRTHS, U.S.B.R.A.		WHITE BIRTHS, U.S.B.R.A. (1915)	
	Sex ratio	No. of births	Sex ratio	No. of births
1915	1055.4	776,304	1056.5	759,085
1916	1057.2	818,983	1058.3	767,533
1917	1058.4	1,353,792	1055.9	782,964
1918	1058.4	1,363,649	1059.1	778,474
1919	1056.5	1,373,438	1052.9	708,914
1920	1056.9	1,508,874	1059.9	749,547
1921	1058.8	1,714,261	1059.3	782,786
1922	1056.5	7,774,911	1055.5	744,384
1923	1056.7	1,792,646	1052.8	746,479
1924	1057.8	1,930,614	1054.0	761,931
1925	1060.4	1,878,880	1054.0	739,838
1926	1056.7	1,856,068	1054.7	717,389
1927	1058.5	2,137,836	1060.8	720,721
1928	1057.2	2,233,149	1056.9	698,884
1929	1056.6	2,169,920	1055.1	672,495
1930	1056.0	2,203,958	1060.0	672,065
1931	1054.5	2,112,760	1054.4	635,268
1932	1053.2	2,074,042	1056.3	605,490
1933	1055.8	2,081,232	1059.4	572,322
1934	1054.8	2,167,636	1051.0	580,400

to 1060.8. This variation is greater than that found for the total area, but the unweighted mean ratio for the twenty-year period differs very little from that noted for the total Registration Area. It is 1056.3 ± .6 in the former and 1056.8 ± .4 in the latter.

The data presented in Table 1 do not seem to support the assumption that during wars or periods of economic and social upheaval there generally occurs a marked alteration in the value of the sex ratio. Even though the United States was actively engaged in the war to the extent of having mobilized over 3 million men by November 1918, no marked change in the value of the sex ratio is to be noted at any time during or immediately after the war. There is a slight rise in 1917 and in 1918

but this may well have been entirely accidental since one of even greater magnitude occurs in 1921 and again in 1925. For the population of the original Birth Registration Area, there is a peak at 1920 and 1921 which, however, is in keeping with the oscillatory character of that series.

The question of the relation between wars and increased masculinity has been debated for a long time. Düsing in 1884 stated that it was a phenomenon frequently to be observed and reported its occurrence in Sweden following the war of 1788-90. Data on Holstein for the period before and after 1848 indicates the same. However, Gini (1908), among others, believed that an increased sex ratio during or following a war is a mere accidental occurrence since he did not find it for any of the countries involved in the Franco-Prussian war of 1870. The last World War permitted more accurate observations to be made and a curious fact appears. During and immediately after the war the sex ratio increased in all the belligerent European countries but it also increased in some of the neutral countries. Among the non-European belligerent countries, it did not increase in the United States as seen above, nor in New Zealand, according to Neale (1924).

Savorgnan (1921) who has discussed the matter at length, believes that the increased sex ratio observed after a war is a consequence of prolonged absence of the husband, greater interval between pregnancies and therefore better condition of the maternal organism to satisfy the requirements of the male foetus. This is a plausible theory on its face which, however, does not explain the increase in the sex ratio in such countries as Norway, Sweden and the Netherlands, with no army in the field and no obvious reason for prolonged absence of a large percentage of husbands. On the other hand, the fact that in the immediate post-war period there was a rise in masculinity more or less marked in a group of European countries cannot be dismissed as being insignificant even though it cannot be attributed to the interval between pregnancies. One of the effects of war common to belligerents and non-belligerents was the economic disruption that followed the end of hostilities. Therefore, one could speculate as Ploss (1858) did that relative malnutrition of the mothers is a selective agent which favors the male against the female foetus. In Saxony, during the period from 1834 to 1854 Ploss found high masculinity associated with years of famine. But Gini (1908) was unable to find any association between famine and increased sex ratio in the records for India during 1896, 1897 and 1900. In the United States the recent economic depression in its acute stage was

comparable to a condition of famine, but the sex ratio for the years following 1929 has not increased—if anything it has decreased.

Explanations other than those based on the interval between pregnancies or on relative malnutrition of the mother must be presented to explain the post-war increase in masculinity noted in certain countries.

VARIATION BETWEEN STATES

Records of the annual sex ratio for at least 10 years are available for 33 states. Statistical constants of the sex ratio of white births computed for each state are presented in Table 2.

The range of variation of the sex ratio in each state is greatest, as expected, for states with a relatively small number of births per annum and is least for the states with a large number of births. Thus, for Delaware, with about 4000 births per year, the sex ratio varies from 960 in 1927 to 1112 in 1934. New York with about 200,000 births annually has had a sex ratio ranging only from 1051 to 1061 in these ten years.

Due to the variation of the sex ratio in any one state during the ten-year period, the order of the states as given in the table is not of great moment. This in part can be deduced from the fact that the unweighted mean sex ratio for each state for the 10 year period does not differ significantly from the mean for all the states combined. Moreover, when each of the 33 states is ranked according to the unweighted mean sex ratio for the two five-year periods 1925-29 and 1930-34, the rank correlation for the two periods is $+ .37 \pm .10$. Although positive and of moderate size, the value of this correlation does not have much significance when the probable error is taken into account. However, there is a group of states that for both five-year periods has consistently had lower than average sex ratio and there is another group that for the same two periods has had a sex ratio above the average of that for all the states combined. In the first group of states are included Virginia, Maryland, Massachusetts, New York, Indiana and Vermont. In the second group are Iowa, Ohio, West Virginia, Illinois, Maine, Connecticut, Kansas, Florida, Kentucky, Nebraska, North Dakota and Montana. Each of these two groups includes states with contrasting geographic and climatic conditions and different degrees of industrialization and urbanism. For example, among the states with above average sex ratio Maine and Florida represent the extreme north and south, Connecticut and Nebraska are typical examples of industrial and of agricultural economy, respectively. At the same time two states with similar climatic or other

geographic or economic conditions are found in opposite groups, thus Ohio and Indiana, Maine and Vermont, New York and Connecticut.

It is to be noted that the white population of the combined group of states with a sex ratio consistently below the average shows a slightly higher mortality, as measured by the crude death rate and the infantile mortality rate, than the white population of the group of states with a sex ratio consistently above the average for the period mentioned. In the total group of 18 states, for the years 1925 to 1933, the mean annual

TABLE 2

Statistical constants of sex ratio of births to white population of 33 states from 1925 to 1934

(Total number of births in decennium = 15,671,027.)

STATES	MEAN SEX RATIO FOR THE 10 YRS.	COEFFICIENT OF SIGNIFICANCE*	LOWEST SEX RATIO	HIGHEST SEX RATIO	STATES	MEAN SEX RATIO FOR THE 10 YRS.	COEFFICIENT OF SIGNIFICANCE*	LOWEST SEX RATIO	HIGHEST SEX RATIO
Mass.	1052.5	1.47	1043	1060	Iowa	1059.5	.02	1049	1069
Wash.	1052.5	1.47	1027	1067	Conn.	1060.0	.13	1034	1080
Vt.	1054.0	1.15	1014	1099	Del.	1060.0	.13	960	1112
N. J.	1055.0	.94	1042	1079	W. Va.	1060.0	.13	1047	1069
Md.	1055.0	.94	1018	1069	Wisc.	1060.5	.23	1045	1073
Ore.	1056.0	.72	1033	1082	Kan.	1060.5	.23	1030	1087
Miss.	1056.0	.72	1026	1088	Ohio	1060.5	.23	1047	1067
Wyo.	1056.0	.72	1030	1087	Ill.	1061.0	.34	1044	1075
N. Y.	1057.0	.51	1051	1061	N. H.	1062.0	.55	1038	1096
Cal.	1057.0	.51	1043	1068	Utah	1062.5	.66	1027	1096
Pa.	1058.0	.30	1042	1067	Mont.	1063.0	.77	1043	1082
Maine	1058.0	.30	1042	1080	N. C.	1067.0	1.62	1048	1083
Ind.	1058.0	.30	1040	1065	Neb.	1067.5	1.72	1047	1085
Va.	1058.0	.30	1031	1071	N. D.	1068.0	1.83	1046	1095
R. I.	1058.5	.19	1022	1072	Ky.	1071.5	2.57	1057	1083
Minn.	1059.0	.02	1040	1075	Fla.	1073.0	2.89	1037	1092
Mich.	1059.5	.02	1046	1065	All States	1059.4±.8			

* Mean sex ratio for state — mean sex ratio for all states

Standard error of difference

number of deaths for 1000 persons was 60.1 ± 1.5. For the combined six states with below average sex ratio this rate was 61.7, while for the twelve states with above average masculinity at birth, the mean annual number of deaths for 1000 persons equalled 59.2. Similarly, in the former group the mean annual number of deaths below age 1 year per 1000 live births was 12.0, and in the latter group it equalled 10.4, while for all 18 states combined it was 10.9 ± .4. However, for both the crude death rate and the infantile mortality rate, the deviation of the mean of each group from that of the total is not statistically significant since it can be due to chance. The lack of association between variation in masculinity at birth and the mortality rates in the population is demonstrated also by the fact that a change in the sex ratio is not reflected by a change, in the same or opposite direction, of the crude death rate and the infantile mortality rate. Between the period of 1925-29 and that of 1930-34, in 20 states there was a decrease in the mean annual sex ratio of the births to the white parents, in 13 states there was either no change or else an increase. The mean difference between the crude death rate of the two periods was —10.5 ± .9 per thousand in the former group of states and —9.0 ± 1.1 per thousand in the latter. The mean difference between the infantile mortality rate of the two periods equalled —.6 ± .2 per thousand in the former group and —.5 ± .1 per thousand in the latter group of states. In other words, both the crude death rate and the infantile mortality rate have decreased in the two groups of states. For each rate the amount of decrease has been practically equal in the population of two groups of states compared notwithstanding that the masculinity of the births has decreased in one group and increased in the other.

From all this, it seems reasonable to conclude that the sex ratio is not significantly and regularly influenced by the geographic, climatic or other demographic differences to be found between the states in this country. This is in agreement with the general observations made in Italy and France (Gini, 1908), although for the latter country it has been stated that the sex ratio was lower for coastal departments and higher for those of the interior.

SEASONAL TREND

The month of birth and consequently the month of conception seems to have a doubtful, if any, influence on masculinity. This is evident in Table 3 where the monthly sex ratio has been calculated for two five-

TABLE 3

Monthly sex ratio for two five-year periods: 1925-29, and 1930-34 in U.S.B.R.A.

(Total births 1925-29 = 10,275,853. Total births, 1930-34 = 10,639,628)

MONTH	SEX RATIO 1925-29	SEX RATIO 1930-34	MONTH	SEX RATIO 1925-29	SEX RATIO 1930-34
January	1061.3	1056.0	July	1059.9	1061.7
February	1054.8	1048.3	August	1059.0	1051.0
March	1055.5	1051.5	September	1057.0	1056.1
April	1057.4	1056.4	October	1054.3	1053.8
May	1059.9	1057.7	November	1057.1	1050.5
June	1063.5	1060.7	December	1054.1	1054.3
			TOTAL	1057.8±.6	1054.9±.6

year periods, 1925-29 and 1930-34, for all the births in the Registration Area.

The table shows that from February until June and July there is an increase in the sex ratio. Thereafter there is a decrease until a low level is reached in October-November, then another increase to a secondary peak in January. The monthly oscillations fall well within the expected deviations from the sex ratio of the total. This is in accord with observations of Lewis and Lewis (1906) who examined data from different sources and found no evidence of a consistent seasonal trend. For the data shown in Table 3, the consistency between the two five-year periods is more apparent than real since actually the trend in the sex ratio from month to month is in disagreement four times out of 12. It is to be noted here that Table 3 also brings out clearly the decline in the sex ratio after 1930. For the period of 1930-34 the sex ratio for each month, except one, is lower than the ratio for the corresponding month of the 1925-29 period.

URBAN AND RURAL

Comparison of the urban and rural sex ratios for the two periods 1925-29 and 1930-34 indicates that there is no significant difference

between the two types of population (Table 4). The urban births, in fact, exhibit a slightly higher sex ratio for the two periods.

TABLE 4

Urban and rural sex ratio for two five-year periods: 1925-29 and 1930-34 in U.S.B.R.A.

YEARS	SEX RATIO	
	Urban	Rural
1925-29	1057.9±.9	1057.8±.9
1930-34	1055.9±.9	1053.9±.9

This is in disagreement with the observations reported elsewhere. Düsing (1884) in Prussia, Lewis and Lewis (1906) in Scotland, Russell (1936) in England, and others are all in agreement that the sex ratio is higher in the rural districts of the country and lower in the urban. Moreover, Russell claims that this is also to be observed in the United States during the period 1927-29. However, a check of his figures shows that the statement is probably based on a computing error. For that period, he found a sex ratio of 1057 ± 1.20 for the urban and one of 1064 ± 1.15 for the rural areas. Recalculation shows that the two sex ratios are respectively 1057.2 ± 1.2 and 1057.6 ± 1.1.

The lack of relationship between urbanization and sex ratio was also noted by Vigor and Yule (1906) for England and Wales, but they believed that the sex ratio increases and then decreases as one passes from the smallest to the largest urban areas. In other words, the largest towns and the most rural areas are supposed to have a higher masculinity than the provincial and semi-urban towns. Bearing on this point, we can utilize the data which classifies the place of birth into urban (cities of 10,000 or more), incorporated places (cities of 2500 to 10,000) and rural districts. For the period of 1930-34 the sex ratio, in order for the three types of population, is 1055.9 ± .9, 1054.4 ± 2.1, and 1053.8 ± 1.0. There is a slight but insignificant trend towards a decline in the sex ratio in relation with decrease in urbanization. In sum, in this country the effect of urbanism on the sex ratio is entirely negligible.

The higher masculinity of rural births, accepted as universal, has been regarded as confirmatory of the theory that the sex ratio at birth is primarily a function of reproductive wastage. This conclusion is based on the assumption that abortions and stillbirths are more frequent for urban than for rural mothers. Official statistics on this point are fragmentary but it will be recalled that Quetelet (1835), for one, established that the ratio of stillbirths to live births is higher for urban than for rural mothers. Recently Alberti (1934) reported a higher abortion rate in a sample of urban Milanese women when compared to rural women. Taussig (1936) cites similar results obtained on samples of Russian and of Czechoslovakian women. In the United States the stillbirth statistics are rather unsatisfactory, however it is noted that the ratio of stillbirths to live births has always been higher in the urban than in the rural areas. In 1930, for example, in the urban areas among the white population there were 3.6 stillbirths for 100 live births and in the rural 3.2. Among the colored population the ratios, in the same order, were 8.6 and 7.5. A similar difference between urban and rural population is observed when the frequency of puerperal mortality due to abortions is taken as an indication of the frequency of abortions. According to the information collected by the Children's Bureau of the U. S. Department of Labor the mortality rate from abortions in their sample was 22 per 10,000 live births in the cities ,and 12 per 10,000 in the country.

In sum, while for the United States all available data point to a greater reproductive wastage in urban than in rural areas, contrary to observations made in other countries, masculinity is not lower in urban than in rural areas. Such being the case a doubt arises as to whether the conclusion is tenable that the birth sex ratio depends essentially on reproductive wastage.

RACE(COLOR) AND NATIONALITY OF PARENTS

In Table 5 are presented separately the sex ratios of the births, to parents both of whom are native white, colored, Austro-Hungarian, Italian, Irish, Russian, Polish, and to parents one of whom is native and the other belongs to one of the five mentioned foreign stocks.

The five foreign nationalities were chosen because they represent those producing annually the largest numbers of births. For the four periods 1917-19, 1920-24, 1925-29 and 1930-34, the sex ratio of the colored births has been definitely and consistently lower than that of births to

TABLE 5

Sex ratio of births in U.S.B.R.A. according to race(color) and nationality of parents

RACE(COLOR) AND NATIONALITY OF PARENTS	SEX RATIO			
	1917-19	1920-24	1925-29	1930-34
Native white × native white	1061.6± 1.4	1068.8±0.9	1063.2± 0.8	1059.2± 0.8
Colored	1028.0± 4.2	1034.0±2.5	1036.2± 2.1	1033.1± 1.9
Austro-Hungarian × Austro-Hungarian	1058.5± 4.7	1063.2±4.5	1048.0± 6.1	1056.5± 9.9
Irish × Irish	1038.6±10.6	1042.2±8.5	1064.3± 9.2	1076.0± 9.8
Italian × Italian	1038.8± 4.2	1035.9±3.1	1034.8± 3.5	1032.3± 4.8
Polish × Polish	1066.5± 9.4	1055.4±4.8	1048.7± 5.6	1044.3± 8.5
Russian × Russian	1063.3± 5.0	1063.3±4.9	1067.7± 6.2	1050.8± 9.0
Austro-Hungarian × native white	1081.7±11.7	1080.8±8.4	1054.6± 8.2	1063.0± 9.5
Irish × native white	1063.3±12.7	1064.4±9.5	1046.2±10.2	1046.9±11.2
Italian × native white	1060.2±11.2	1043.8±6.3	1054.2± 5.4	1045.4± 5.6
Polish × native white	1065.7±20.9	1058.6±9.5	1056.9± 8.7	1043.5± 9.4
Russian × native white	1059.7±11.8	1062.6±8.4	1061.2± 7.7	1063.3± 8.2

white parents, one or both natives of the United States. Except for the births to Italian parents, the sex ratio of the colored births has also been lower than that of births to white parents both of whom are foreign. The sex ratio of the offspring of native white parents occupies an intermediate position when compared to the sex ratio to parents of other nationalities. A phenomenon which confirms observations made elsewhere is the reduction in the masculinity of births to Italian parents in this country when compared to the sex ratio of births in Italy. In this country they demonstrate almost always the lowest masculinity. In the four periods, the sex ratio of births to Italian couples is always lower than that for the births to Italian × native couples. The same is to be observed for the births to Austro-Hungarian couples but it does not occur regularly for the Irish, Polish or Russian stocks. Since the latter two groups have a large proportion of Jews it is unknown how many of the mixed couples, i.e. Russian or Polish × native are really mixed.

The higher masculinity of the hybrid births is not so striking here as it is for the population of Buenos Aires studied by Pearl and Pearl

TABLE 6

Column A presents the sex ratio of births to native born white parents minus the sex ratio of births to parents both of whom were born in country indicated. Column B presents the sex ratio of births to parents one of whom was native born white and the other born in country indicated minus the sex ratio of births to parents both of whom were born in country indicated

COUNTRY	1917-19		1920-24		1925-29		1930-34	
	A	B	A	B	A	B	A	B
Austria-Hungary	+ 3.1± 4.9	+23.2±12.6	+ 5.6±4.6	+17.6± 9.6	+15.2±6.2	+ 6.6±10.2	+ 2.7±10.0	+ 6.5±13.7
Ireland	+23.0±10.7	+24.7±16.5	+26.6±8.6	+22.2±12.7	− 1.1±9.3	−18.1±13.7	−16.8± 9.9	−29.1±14.9
Italy	+22.8± 4.4	+21.4±11.9	+32.9±3.4	+ 7.9± 7.0	+28.4±3.8	+19.4± 6.5	+26.9± 5.0	+13.1± 7.4
Poland	− 4.9± 9.5	− 0.8±22.9	+13.4±5.0	+ 3.2±10.7	+14.5±5.8	+ 8.2±10.3	+14.9± 8.6	− 0.8±12.6
Russia	− 1.7± 5.2	− 3.6±12.8	+ 5.5±5.1	− 0.7± 9.7	− 4.5±6.4	− 6.5± 9.9	+ 8.4± 9.1	+12.5±12.2

(1908). Nevertheless, it is interesting to note that in 13 of the twenty comparisons, the sex ratio is higher in the hybrid. In five of the remaining seven for which the sex ratio of the hybrids is lower, the sex ratio of the "pure" foreign bred is also higher than that of the "pure" native. This is seen more clearly in Table 6.

Here for each foreign group, the difference in sex ratio between the "pure" bred and the hybrid has been compared to the difference between the "pure" bred and the native. In 18 of the twenty comparisons, the signs of the two differences are the same. It would seem then that the level of the sex ratio of the hybrid results from a mixture or combination of the levels of the sex ratios characteristic of the national groups to which the parents belong.

These findings cannot be adequately explained without having recourse to speculation. All realize that the term "native" has not the same biologic meaning for the population of this country that it has for the populations of older countries. In particular it is to be remarked that the native born person who marries a foreign born person is often of the same stock as the foreign born, so too much value cannot be given to the observations made on hybrids, even though the consistency of the results are interesting. There is plainly a suggestion here of the existence of a constitutional factor in masculinity.

The belief that the observed sex ratio of birth is primarily a function of reproductive wastage might seem to be supported by the data on the sex ratio of colored births. However, this would mean that the reproductive wastage is about as great in the colored as in the immigrant Italians, an assumption which is contrary to what facts there are. The only data available bearing on this point are the statistics on stillbirths. These show that from 1922 to 1934 the number of stillbirths per 100 live births is 4.4 for the Italian mothers and 7.4 for the colored. The difference is statistically significant and emphasizes again that reproductive wastage is probably not as important a causal factor of masculinity as has been generally assumed.

The repeated observations regarding the low sex ratio in migrant Italians seems to be of particular importance inasmuch as it indicates some environmental factor which affects masculinity. Such a factor does not affect the maternal organism alone but the paternal as well. This is clearly seen from the data on hybrid Italian births. The bulk of mixed Italian native marriages in this country is due to Italian men marrying native women. This suggests that the men may be at least

partly responsible for the relative low sex ratio of the births to these couples.

ILLEGITIMACY

Data on the sex ratio of illegitimate births are available in this country only for the years after 1925. For the periods, 1926-29 and 1930-34, the sex ratio for all the illegitimate births has been 1033.4 ± 4.4 and 1039.9 ± 3.4 respectively. These are significantly much lower ratios than those found for the general population. In other countries the same phenomenon has been repeatedly observed. Heape (1909) reported it in Cuba, and Düsing (1884) in Prussia among others. However, Russell (1936) does not find it in England nor did Srdínko (1908) observe it in Austria.

TABLE 7

Sex ratio in illegitimate white and colored births in U.S.B.R.A., 1926-29 and 1930-34

(Total number of white births = 285,709. Total number of colored births = 306,659.)

YEARS	SEX RATIO OF ILLEGITIMATE BIRTHS	
	White	Colored
1926-29	1056.4±6.3	1018.9±6.1
1930-34	1060.1±5.1	1022.7±4.6

The low sex ratio for illegitimate births in the United States is more apparent than real. It results from an abnormal composition relative to race(color) of the population reproducing when not in wedlock. Among all births, legitimate and illegitimate together, 10 percent were colored in 1926-29 and 13 percent were colored in 1930-34. Instead, among the illegitimate births there were respectively 49 and 54 percent colored in the two periods. If the white and colored illegitimates are considered separately the sex ratios shown in Table 7 are obtained.

For the white population, the sex ratio of the illegitimate births is certainly not any lower than that of the general population, while that

for the colored illegitimates it is only insignificantly lowered. It is clear then that illegitimacy and associated social conditions cannot be held responsible in this country, at least, for variation in the sex ratio.

The lower sex ratio of illegitimate births observed in other countries has been regarded due to the higher frequency of abortions and miscarriages associated with illegitimacy. Relative to this hypothesis the same remarks are applicable as those made in discussing urbanism and masculinity.

ORDER OF BIRTH

There is almost universal agreement that the sex ratio is higher among the first born and lower in the subsequent births. This fact has been established by a number of writers and for a number of countries. Lewis and Lewis (1906) found it in Scotland, Savorgnan (1933) has reported it for Italy, Holland and Prussia.

For the United States during the period of 1925-29 the sex ratio, as shown in Table 8, decreases regularly with increase in the birth order. It is thus in agreement with the general observations. As an explanation, students of the subject as usual believe that it is due to the fact that multiparae have a greater reproductive wastage than primiparae, and that the maternal organism is generally in better physiological condition before the first birth than after a series of pregnancies, especially if these occur at short intervals.

AGE OF PARENTS

Since the report of Hofacker in 1827 and that of Sadler in 1830, the relation between age of parents and sex ratio of births has received

TABLE 8

Sex ratio according to order of birth in U.S.B.R.A., 1925-29

BIRTH ORDER	SEX RATIO
1	1063.2±1.2
2	1059.9±1.5
3	1059.0±1.8
4	1053.3±2.1
5 and above	1051.0±1.4

TABLE 9

Sex ratio of births and age of fathers and mothers, U.S.B.R.A.

(Including only births for which ages of both parents were known.)

AGE IN YEARS	FATHERS				MOTHERS			
	1917-19	1920-24	1925-29	1930-34	1917-19	1920-24	1925-29	1930-34
19 and under	1077.6	1060.7	1057.2	1053.7	1061.0	1059.3	1059.0	1058.0
20-24	1057.6	1063.6	1061.3	1059.7	1055.4	1060.6	1061.8	1058.1
25-29	1059.4	1059.8	1061.6	1058.0	1061.0	1059.3	1060.2	1056.3
30-34	1060.9	1057.4	1060.9	1056.0	1060.0	1051.7	1058.2	1054.3
35-39	1055.4	1052.9	1055.4	1053.9	1055.8	1056.0	1051.3	1052.6
40-44	1056.6	1051.6	1051.6	1047.9	1051.7	1048.2	1044.7	1042.1
45-49	1046.7	1052.7	1051.1	1050.1	1036.2	1056.5	1027.2	1052.4
50 and over	1063.3	1049.7	1039.9	1050.8				
Under 30	1059.2±1.6	1061.2±1.1	1061.3±1.0	1058.1±1.0	1058.5±1.3	1059.8± .9	1060.7± .8	1057.4± .8
30 and over	1057.4±1.4	1054.4± .9	1056.1± .9	1053.3± .9	1057.6±1.8	1052.8±1.2	1054.0±1.1	1052.3±1.2

considerable attention. Numerous observations have been reported. Some indicate that the older the parents, the lower the male sex ratio, others do not justify this conclusion. The data for the United States are presented in Tables 9 and 10.

TABLE 10

Sex ratio of births and age differences between fathers and mothers

AGE DIFFERENCE	SEX RATIO 1017-19	1920-24	1925-29	1930-34
Father and mother same age	1060.6±1.8	1059.9±1.2	1059.6±1.1	1056.5±1.1
Father older than mother	1057.0±1.6	1055.2±1.1	1058.5±1.0	1055.3±1.0
Father younger than mother	1058.1±5.1	1059.5±3.5	1056.3±3.5	1054.8±3.4

It is apparent that there is no consistent trend in increase or decrease in the sex ratio relative to the ages of the fathers or mothers. When the material is grouped into two age classes only—below 30 and above 30 years—it does appear that that the younger parents have a higher sex ratio than the older. The differences are consistent and are significant for all periods except 1917-19.

Some writers believe that the relation between age of parent and sex ratio is manifest for the fathers rather than for the mothers. Our data cannot be used to support any such conclusion, since for both fathers and mothers, when the ages of either are kept constant, there is irregularity in the relationship between age of parent and relative masculinity.

With regard to the *relative* ages of the father and mother, the data for the United States indicate that the male sex ratio is higher when the father and mother are of the same age (to five-year class units), and slightly but not significantly lower when the ages of the fathers and mothers are unequal. These data thus do not fall in line with the observations of Hofacker, Sadler and others who have alleged that the sex ratio was lowest when the fathers were younger than mothers, and high-

est when this situation was reversed. If the differences were statistically significant, the findings reported here would be in agreement with the observations of Stieda (1875) who found that the highest sex ratio was obtained when father and mother were of the same age. The effect of the age of the parents on the sex ratio of births, even when found, has not received a consistent explanation. Some believe that it is due to association between parental age and other factors such as parity of birth, others assume that it is due to age changes in the quality of either the ova or spermatozoa.

STILLBIRTHS AND ABORTIONS

Statistics on stillbirths and abortions are in general defective for a number of reasons. For example, the definition of stillbirths varies from place to place and even in the United States it differs for a number of states. Information regarding abortions is usually not available because there is no registration requirement. Moreover in the very early months of pregnancy abortions can often occur unobserved. Relative to the sex ratio of stillbirths and abortions there is the added difficulty that the sex of the foetus cannot be recognized until the sixth or seventh week of life and even after that age there are sometimes uncertainties. In spite of these obstacles in obtaining adequate data, it is a well established fact that intra-uterine mortality is higher for the male than for the female. This is deduced from numerous observations which indicate that there are born dead from 1250 to 1350 males for every 1000 females (Schultz, 1918). It has also been shown repeatedly that the masculinity of the stillborn is higher for abortions in the early periods of uterogestation and decreases with duration of pregnancy.

While for the whole of the United States population statistics on stillbirths and abortions are as defective as in most countries, a laudable attempt has been made to obtain reliable and comprehensive information in a selected area. This comprises seven states: Connecticut, Illinois, New Jersey, New York, Oregon, Washington and West Virginia; the District of Columbia and Baltimore, Md. In Table 11, data on the sex ratio of stillbirths according to the duration of uterogestation are presented for the population of this selected area for the years 1925 to 1929, 1930 to 1934 and for the 10 years 1925 to 1934.

From Table 11 it is seen that in the ten-year period among all the stillbirths whose sex was recognized there were 1330.3 males for every 1000 females. It will also be noted that the sex was recognized in only a

TABLE 11

Sex ratio of stillbirths in a selected area of the United States classified according to period of uterogestation, 1925-29, 1930-34 and 1925-34

PERIOD OF UTEROGESTATION IN MONTHS	STILLBIRTHS, 1925-29			STILLBIRTHS, 1930-34			STILLRIRTHS, 1925-34		
	Sex ratio	Sex recognized in		Sex ratio	Sex recognized in		Sex ratio	Sex recognized in	
		No.	*Percent*		*No.*	*Percent*		*No.*	*Percent*
Under 2	1153.8	28	14.7	3500.0	54	8.7	2280.0	82	10.1
2	4333.3	192	30.8	4300.0	371	26.4	4311.2	563	27.8
3	3639.1	1067	67.1	3586.0	1321	60.5	3610.0	2388	63.2
4	2098.8	2947	90.6	1942.1	3454	88.7	2012.2	6401	89.5
5	1419.7	6267	97.7	1372.9	6274	97.2	1396.1	12541	97.4
6	1266.6	8960	99.0	1189.2	8897	99.0	1227.4	17857	99.0
7	1150.7	11276	99.4	1098.9	11833	99.3	1124.0	23109	99.4
8	1220.9	12064	99.6	1267.0	16839	99.6	1247.5	28903	99.6
9	1356.9	39881	99.8	1333.4	29051	99.7	1346.9	68932	99.8
10 and over	1389.6	1609	99.7	1251.1	1058	99.5	1332.8	2667	99.6
All stillbirths including those of unknown period	1341.4	94964	97.8	1318.4	86584	96.0	1330.3	181548	96.9

small percentage of the stillborn in the early months of uterogestation. This fact emphasizes the necessity for caution in accepting these observations. However, it should be noted that when the sex ratios of 1925-29 period are compared to those of the 1930-34 period there is remarkable close agreement except for the ages at the two extremes of the series. It is possible then to combine the data for the two periods. For the ten years taken together, it appears that from the second to the fifth month there is a rapid decline in the masculinity of the stillborn, from the fifth to the seventh month the decline continues but is slow and after the seventh month there is a slight increase. The greater masculinity among the stillborn of 8 to 10 months is attributed usually to a greater liability of the male to birth injuries.

The figures given in Table 11, agree in general with those published by Auerbach (1912) based on statistics of Budapest. Schultz (1918) however, believes that Auerbach's figures are exaggerated due to error

in recognizing the sex of the foetus. In Schultz's sample of about 600 foetuses, he obtained a sex ratio of 1237, 1105 and 1081 among the stillborn in the third, fourth and fifth month respectively. These ratios are much lower than those presented here. Schultz assumes also that for every 100 live born there are 4 stillborn at 8-10 months, 9 at 4-7 months and 14 at 3 months or less and on the basis of these data arrives at the conclusion that 1084.7 males are conceived for every 1000 females. Adopting these same assumptions—which are derived from the clinical experience of well known obstetricians—from the figures given in Table 11 it would result that 1372.2 males are conceived for every 1000 females. This primary sex ratio is much higher than the estimates ranging from 1080 to 1164 reported by other writers. Since this figure and the others reported are only estimates each based on assumptions far from secure and on data not entirely reliable, it seems unnecessary to attempt to explain the apparent discrepancy.

If variation in the sex ratio at birth is primarily a function of variation in intra-uterine mortality it would be expected that, for any given population, whenever there occurs a secular decrease in the masculinity of live born there should occur a corresponding increase in the stillbirth rate and in the stillbirth sex ratio, and *vice versa*. As it has been said, in this country not all the states have adopted a uniform registration method for stillbirths, therefore inter-state comparisons are not valid. It is possible to compute for each state separately the number of times that, in two successive years, the stillbirth rate per 1000 total births on the one hand, and the live birth sex ratio on the other hand, have both increased or decreased concurrently, and the number of times that one has increased while the other decreased. If there is a covariation between these two indices, positive or negative, the relative frequency of either of these two conditions should deviate significantly from 50 percent.

The covariation between live birth sex ratio and stillbirth rate in the 10 years from 1925 to 1934 has been calculated in this manner for the white population of the 33 states mentioned in Table 2. Since no information on the stillbirth rate is available for California in 1930, there is a total of 296 possible changes. Excluding instances when either the live birth sex ratio or the stillbirth rate has not changed between two successive years, this total is reduced to 236. In 120 or 50.8 percent of the 236 possible changes, it is found that in two successive years both the live birth sex ratio and the stillbirth rate have either increased or

decreased together. In 116, or 49.2 percent, concurrently with an increase in one of these indices there occurred a decrease in the other. Neither of these two percentages differs significantly from 50 ± 3.3 percent, the expectation on the basis of chance alone. Therefore it may be concluded that successive changes in the live birth sex ratio are not associated in direction with successive changes in the stillbirth rate.

Analysis of the covariation between the annual live birth sex ratio and the annual stillbirth sex ratio leads to similar results. In this case, data on the white population of the same states but from 1925 to 1930 only have been utilized. In two instances one or the other of the indices did not alter between two successive years. With these excluded, there remain 163 possible changes. It was found that in 77 instances, or 47.2 percent, both the live birth sex ratio and the stillbirth sex ratio increased or decreased together between two successive years. In 86 instances, or 52.8 percent, one decreased while the other increased. Neither of these percentages is significantly different from 50 ± 3.9 percent.

From these observations it seems safe to conclude that the annual changes in the live birth sex ratio do not reflect annual changes in either the stillbirth rate which measures the extent of intra-uterine mortality or in the sex ratio of the stillborn, presumably a measure of the vitality of the male foetus. These findings by no means exclude intra-uterine mortality as a causal factor in the variation of the sex ratio at birth, but they certainly seem to indicate that it is not the only or perhaps even primary factor.

SUMMARY AND DISCUSSION

A survey of the variation of the sex ratio at birth in the United States and of the relation of this variation to a number of other demographic conditions allows us to discard some of the factors that from time to time have been regarded as causally concerned with changes in the sex ratio. They include such variables as degree of urbanism, legitimacy of birth, season of the year and age differences between the parents. If these elements are ever actually associated with an increased or decreased sex ratio it must be concluded that the interrelationship is neither constant nor necessary.

This conclusion is deduced from the following observations:

(1) There is no significant difference between the sex ratio for urban and for rural populations. Not only is there no indication of an

increased sex ratio in rural areas, but the data for the United States show that the urban population has a very slight, if insignificant, superiority.

(2) The sex ratio for illegitimate births is practically equal to that for legitimate births when race(color) is taken into account.

(3) While the monthly variation in the sex ratio apparently demonstrates high points in June-July and January and low points in February and October-November, the amplitude of the fluctuations cannot be regarded as statistically significant.

(4) No significant difference could be found in the sex ratio of births when the parents were of the same age and when they were of different ages.

The data presented here give indirect evidence to indicate that in the United States, neither war, nor economic upheaval, nor climatic and geographic differences, nor general mortality and infant mortality, nor variations in the stillbirth rate and in the stillbirth sex ratio, is causally related to fluctuations in the sex ratio, as many workers have assumed.

It has been shown that:

(1) The sex ratio for the United States population was not altered in the period following the World War.

(2) The rise of the sex ratio theoretically to be expected on certain current views during the recent economic depression did not take place.

(3) Comparison of the annual sex ratio in 33 states shows that geographic and climatic conditions, as varied as those to be found in the United States are not significantly related to masculinity.

(4) In the population of 20 states for which the sex ratio decreased between 1925-29 and 1930-34 there occurred a decrease in the crude death rate and in the infantile mortality rate equal in amount to the decline observed in the population of 13 states for which the sex ratio either remained unchanged or increased between the two periods mentioned.

(5) For the population of 33 states it is found that there is no association, either positive or negative, between annual changes in the live birth sex ratio and annual changes in the stillbirth rate and in the stillbirth sex ratio.

In relation to variation in the sex ratio in this country the following observations seem of importance. On the basis of the birth statistics of recent years, it appears that:

(1) Since 1930 there has been a slight decline in the sex ratio.

(2) The sex ratio of colored births is consistently and markedly lower than that of births to native white parents.

(3) The sex ratio of births to parents one of whom is of a certain foreign stock and the other is native born, is higher than the sex ratio of births to parents both of whom are of that certain foreign stock when the sex ratio of the latter is lower than that of births to native parents. When this situation is reversed, then the sex ratio of births to parents one of whom is of a certain foreign stock and the other native born is generally lower than the sex ratio of births to parents both of whom are of that particular foreign stock.

(4) The sex ratio decreases as the order of birth increases.

(5) The relation between the age of the parents and the sex ratio of the births is rather irregular but it seems to indicate that the births to parents below 30 years of age have consistently a higher sex ratio.

These facts do not admit of a simple and unique explanation, since the sex ratio at birth is the resultant of the action of several variables. The first of these is the sex ratio at conception, and regarding it there is no definite information. Three hypotheses are possible: (1) as many males as females are conceived, (2) more females than males are conceived, (3) more males than females are conceived.

The first hypothesis would, in general, be in agreement with current Mendelian expectation. But we know that from the earliest stage when sex is recognizable the intra-uterine mortality is higher for the male. So, on the first hypothesis, in order to arrive at the usual sex ratio at birth, one must assume that there is a very high female mortality during embryonic development. Such an assumption is, however, contrary to the general experience and observation regarding the differential mortality according to sex. The second hypothesis, like the first, necessarily demands a much greater female than male intra-uterine mortality, for which, as we know there is no evidence in fact.

The third hypothesis postulates that many more males than females are conceived. It is assumed also that intra-uterine mortality is always greater for the males, since it is known that this is so after the second month of intra-uterine life. This hypothesis is favored by most students of the subject, who further estimate that the sex ratio at conception is at least as high as 108 males for 100 females or perhaps even higher. On the basis of this hypothesis the sex ratio at birth is then to be regarded as the possible resultant of the action of at least two

variables: differential selectivity and viability of the sperm carrying the male determiners, and a sex differential in reproductive wastage.

Curiously enough, nearly all the explanations and theories regarding the sex ratio in man have emphasized almost exclusively the second variable only. In addition, while both of these variables presumably can be affected by heredity as well as by environment, students of the subject have mostly limited themselves to a consideration of the influence of environmental factors.

The viewpoint held by many students of the subject is well exemplified by the very recent paper of Crew (1937) which appeared while this work was in progress. Crew has attempted an elaborate synthesis of the observations on the sex ratio both in man and other animals from which he infers, for example, that "movements in the secondary sex ratio can therefore be used as a measure of the success or otherwise of the social services, of slum clearance, of the general health of a community". (p. 534). This inference follows from assuming that variation in the sex ratio at birth is associated with degree of urbanization, illegitimacy of birth and other demographic factors which, as we have shown, certainly cannot on the factual evidence be shown to be of primary importance, at least so far as the population of the United States is concerned. This inference implies that an increase or decrease in the sex ratio will reflect respectively a decrease or increase in the general mortality and infantile mortality rates, the two indices which are generally accepted as a measure of the state of the public health. Such is not the case as has been shown for the white population of 33 states. Moreover for the United States as a whole, between 1915-17 and 1932-34, the general mortality rate has decreased by 40.4 percent and the infantile mortality rate by 24.4 percent, but the sex ratio has not increased. Instead it has declined by 0.2 percent.

The asumption that intra-uterine mortality, whatever its causes, is the major, if not the sole significant influence that determines the sex ratio at birth, in the sense that high intra-uterine mortality causes a low sex ratio and low intra-uterine mortality causes greater masculinity, characterizes Crew's study as well as that of many other students. It is suggested that this mode of reasoning possibly lends itself to a little too ready acceptance of the facts which fit the hypothesis, with a corresponding underweighting disregard of those that do not. Thus, for example, it is taken for granted that a greater frequency of abortions and stillbirths accounts for the low sex ratio of the colored births rela-

tive to that of white births in general. Yet the masculinity of colored births is *not* definitely lower than that of births to Italian immigrants, although the stillbirth rate of the colored births is significantly lower than that of Italian births in this country. That reproductive wastage is not the major factor in the variation of the sex ratio is indicated also by the observation that there is no association, either positive or negative, between annual changes in the live birth sex ratio and annual changes in the stillbirth rate and in the stillbirth sex ratio.

In view of all these considerations, might it not be the part of wisdom to replace some of the effort that goes into speculative rationalization about differential foetal mortality with really intensive research to find more exact facts about this mortality in man? What plainly appears to be needed is a systematic evaluation of all the elements which on general biological grounds presumably can be related to increased or decreased masculinity at birth in man.

BIBLIOGRAPHY

[ANON.] 1937. The sex ratio. *Nature*, Vol. 140, pp. 958-959.

AHLFELD, F. 1912. Der Einfluss des Alters der Mutter auf das Geschlecht des Kindes. *Monatschr. f. Geburtsh. u. Gynäk.*, Vol. 36, pp. 271-278.

ALBERTI, S. 1934. La Mortalità Antenatale. *Milano* (Soc. Ed. Vita e Pensiero).

AMAR, J. 1929. Sexe et nutrition. *Compt. Rend. Acad. Sci.*, Vol. 188, pp. 935-937.

AUERBACH, E. 1912. Das wahre Geschlechtsverhältnis des Menschen; ein Versuch zu seiner Berechnung. *Arch. f. Rassen- u. Gesellsch.- Biol.*, Vol. 9, pp. 10-17.

BAYER, A. 1925. Geschlechtsproportion und Krieg. *Monatschr. f. Geburtsh. u. Gynäk.*, Vol. 68, pp. 1-17.

BLUMENFELD, E. 1925. Statistische Erhebungen über das Geburtenmaterial von Juli 1912 bis Dezember 1920 unter besonderer Berücksichtigung der Kriegsverhältnisse. *Monatschr. f. Geburtsh. u. Gynäk.*, Vol. 68, pp. 302-308.

BOHÁČ, A. 1936. Die Theorie des statistichen Ausgleichs und das Geschlechtsverhältnis der Geborenen. *Bevölkerungsfragen. München* (J. F. Lehmanns Verlag), pp. 446-449.

BOLDRINI, M. 1936. La proportion des sexes dans les conceptions humaines. *Rev. Inst. Internat. Stat.*, Vol. 4, pp. 484-499.

BRIDGES, C. B. 1932. The genetics of sex in *Drosophilia*. *Sex and Internal Secretions. Baltimore* (William and Wilkins).

CREW, F. A. E. 1923. Studies in intersexuality. Part II. Sex-reversal in the fowl. *Proc. Roy. Soc.*, Vol. 95, pp. 256-280.

CREW, F. A. E. 1927. Concerning fertility and sterility in relation to population. *Proc. World Pop. Conf. London* (Edward Arnold), pp. 214-249.

CREW, F. A. E. 1937. The sex ratio. *Amer. Nat.*, Vol. 71, pp. 529-559.

DANTSCHAKOFF, V. 1935. Déterminisme et Réalisation dans le Devenir du Sexe. *Paris* (Hermann et Cie).

DOHRN, R. 1888. Hat der enge Becken Einfluss auf die Entstehung des Geschlechts? *Ztschr. f. Geburtsh. u. Gynäk.*, Vol. 14, pp. 80-81.

DÜSING, C. 1884. Die Regulierung des Geschlechtsverhältnisses bei der Vermehrung der Menschen, Tiere und Pflanzen. *Jenaische Ztschr. f. Naturw.* N. F., 10, pp. 593-940.

ERDMANN, P. 1891. Ueber alte Erstgebärende und ihre Sterblichkeit unter dem Einflusse der Antisepsis. *Arch. f. Gynäk.*, Vol. 39, pp. 53-114.

FAIRER, J. A . 1919. Male birth rate in war time. *Med. Officer*, Vol. 21, p. 188.

FURST, C. 1887. Knabenüberschuss nach Conception zur Zeit der postmenstruellen Anämie. *Arch. f. Gynäk.*, Vol. 28, pp. 14-38.

GÄNSSLE, H. 1921. Ueber Geschlechtsbestimmung und Krieg. *Ztschr. f. Geburtsh. u. Gynäk.*, Vol. 84, pp. 159-178.

GATENBY, J. B. 1927. Polar bodies. *Irish Jour. Med. Sci.*, Vol. 6, pp. 152-153.

GEISSLER, A. 1889a. Beiträge zur Frage des Geschlechtsverhältnisses der Geborenen. I. Das Geschlechtsverhältniss bei den Kindern gleichen Stammes. *Ztschr. des K. Sächs. Statist. Bureaus*, Vol. 35, pp. 1-24.

[GEISSLER, A.] 1889b. Nachtrag zu Artikel: I. Das Geschlechtesverhältniss bei den Kindern gleichen Stammes. *Ztschr. des K. Sächs. Statist. Bureaus*, Vol. 35, p. 56.

GEISSLER, A. 1889c. Die Bewegung der Bevölkerung im Königreiche Sachsen während des Jahres 1888. *Ztschr. des K. Sächs. Statist. Bureaus*, Vol. 35, pp. 216-236.

GINI, C. 1908. Il Sesso dal Punto di Vista Statistico. *Milano* (Remo Sandron).

GOEHLERT, V. 1890. Die menschliche Reproductionskraft. *Wien. Klinik*, Vol. 16, pp. 247-274.

GOETSCH, W. 1926. Neue Untersuchungen über Geschlechtsbestimmung. *Münch. med. Wchnschr.*, Vol. 73, pp. 1103-1104.

GREULICH, W. W. 1931. The sex ratio among human stillbirths. *Science*, Vol. 74, pp. 53-54.

HEAPE, W. 1909. The proportion of the sexes produced by white and coloured peoples in Cuba. *Philos. Trans. Roy, Soc. London*, Vol. 200, pp. 271-300.

HERON, D. 1906. On the inheritance of the sex-ratio. *Biometrika*, Vol. 5, pp. 79-85.

HIRSCH, G. 1919. Befruchtungsfähigkeit der Frau und Geschlechtsbestimmung. *Arch. f. Frauenk. u. Eugenetik*, Vol. 4. pp. 102-104.

HOFACKER. 1827. Ueber die Bestimmung des Geschlechts durch verschiedene Momente. *Med.- Chir. Ztg.*, Vol. 4, p. 398.

HOLDER, A. B. 1892. Gynecic notes taken among the American Indians. *Amer. Jour. Obst.*, Vol. 26, pp. 41-60.

DE JASTRZEBSKI, S. 1919. The sex ratio at birth. *Eug. Rev.*, Vol. 11, pp. 6-16.

VON KALCKSTEIN, W. 1904. Ein Beitrag zur Statistik der Geburten, insbesondere der Mehrgeburten. *Allg. statist. Arch.*, Vol. 6. pp. 294-297.

KISCH, E. H. 1887. Zur Lehre von der Bedeutung des Geschlechtes. *Centralbl. f. Gynäk.*, Vol. 11, pp. 49-51.

[LAGNEAU.] 1882. Comparative birth- and death-rates. *Lancet*, Vol. 1 for 1882, p. 623.

LEWIS, C. J., and J. N. LEWIS. 1906. Natality and Fecundity. *London* (Oliver and Boyd).

LOMMATZSCH, G. 1902. Die Bewegung der Bevölkerung im Königreiche Sachsen während des Jahres 1900. *Ztschr. d. K. Sächs. Statist. Büreaus*, Vol. 48, pp. 1-26.

MALLET, B. 1918. Vital statistics as affected by the War. *Jour. Roy. Stat. Soc.*, Vol. 81, pp. 1-36.

MIJSBERG, W. A. 1926. Het jongensoverschot onder de geborenen en de getalsverhouding der beide seksen bij de conceptie. *Nederlandsch. Tijdschrift v. Geneeskunde*, Vol. 70, pp. 846-853.

NAKAGAWA, J. 1932. On the elderly pluripara. *Jap. Jour. of Obst. and Gynec.*, Vol. 15, pp. 402-405.

NEALE, E. P. 1924. A New Zealand study of natality. *Jour. Amer. Stat. Ass.*, Vol. 19, pp. 454-467.

NIXON, J. W. 1916. War and national vital statistics with special reference to the Franco-Prussian War. *Jour, Roy. Stat. Soc.*, Vol. 79, pp. 418-444.

OPPENHEIM, F. 1926. Sex-ratio at birth of the Chinese. *China Med. Jour.*, Vol. 40, pp. 634-640.

PEARL, M., and R. PEARL. 1908. On the relation of race crossing to the sex ratio. *Biol. Bull.*, Vol. 15, pp. 194-205.

PEARL, R. 1937. Variation in parity of women bearing children in the U. S. Birth Registration Area in 1930. HUMAN BIOLOGY, Vol. 9, pp. 65-98; 212-244.

PINARD, A. and A. MAGNAN. 1913. Recherches sur la sexualité dans les naissances. *Compt. Rend. Acad. Sci.*, Vol. 156, pp. 1396-1399.

PINARD, A. and A. MAGNAN. 1913a. Sur la fragilité du sexe mâle. *Compt. Rend. Acad. Sci.*, Vol. 156, pp. 401-404.

PLOSS, H. 1858. Ueber die das Geschlechtsverhältniss der Kinder bedingenden Ursachen. *Monatschr. f. Geburtsk. u. Frauenk.*, Vol. 12, pp. 321-360.

POHLEN, KURT. 1937. Das Geschlechtsverhältnis der Geborenen nach grossen Kriegen. *Deut. med. Wchnschr.*, Vol. 63, pp. 311-312.

POWDERMAKER, H. 1931. Vital statistics of New Ireland (Bismarck Archipelago) as revealed in genealogies. HUMAN BIOLOGY, Vol. 3, pp. 351-375.

PRINZING, F. 1910. Totgeburten, Kindersterblichkeit, und Geschlechtsverhältnis der Geborenen in England und Japan. *Ztschr. f. soz. Med.*, Vol. 5, pp. 295-308.

QUETELET, A. 1835. Sur l'Homme et le Développement de ses Facultés, ou Essai de Physique Sociale. *Paris* (Bachelier).

RIFE, D. C., and L. H. SNYDER. 1937. The distribution of sex ratios within families in an Ohio city. Studies in human inheritance, XVI. HUMAN BIOLOGY, Vol. 9, pp. 99-103.

ROLCKE, E. 1915. Einfluss des Alters der Eltern auf das Geschlecht der Kinder? *Allg. Statist. Archiv.*, Vol. 9, pp. 45-69.

RUSSELL, W. T. 1936. Statistical study of the sex ratio at birth. *Jour. of Hyg.*, Vol. 36, pp. 381-401.

SADLER, M. T. 1830. The Law of Population. *London* (J. Murray).

SAVORGNAN, F. 1921. L'aumento delle nascite maschili durante la guerra. *Metron*, Vol. 1, pp. 131-160.

SAVORGNAN, F. 1931. La fecondità delle aristocrazie. 4. Le case principesche d'Italia, Germania, Austria, Ungheria, Russia, Polonia. *Metron*, Vol. 9, pp. 53-97.

SAVORGNAN, F. 1933. La statistica delle nascite legittime secondo l'ordine di generazione. Movimento della popolazione secondo gli Atti dello Stato Civile negli anni 1929 e 1930. *Roma* (Instituto Poligrafico dello Stato).

SCHMIDT, P. 1918. Über den Einfluss der Kriegsernährung auf das Körpergewicht der Neugeborenen. *Monatschr. f. Geburtsh. u. Gynäk.*, Vol. 47, pp. 391-405.

SCHÖNER. 1927. Besteht eine Beziehung zwischen dem Geschlechte und der Seite des Corpus-luteum-Sitzes? *Schweizerische med. Wchnschr.*, Vol. 57, pp. 953-954.

SCHULTZ, A. H. 1918. Studies in the sex-ratio in man. *Biol. Bull.*, Vol. 34, pp. 257-275.

SRDÍNKO, O. 1908. Das Geschlechtsverhältnis bei den Geburten in Oesterreich. *Arch. f. Gynaek.*, Vol. 84, pp. 741-824.

SRDÍNKO, O. 1908. Reprodukční schopnost obyvatellstva v království Českém. [Reproductivity of the Bohemian population.] *Časop. lék. Česk.*, Vol. 47, pp. 1377-1380; 1414-1420.

SRDÍNKO, O. 1908. Děti z dvojčat a víceporodů a jich pohlaví. [Twins, and other multiple births, and their sex.] *Časop. lék. Česk.*, Vol. 47, pp. 298-301.

SRDÍNKO, O. 1908a. Die Kinder aus Zwillings- und Mehrgeburten und ihr Geschlecht. *Rev. de Med. Tcheque*, Vol. 1, pp. 19-21.

SRDÍNKO, O. 1917. [Births in Bohemia and in Austria in the years 1903-1913 and their sex-ratio.] *Lékařské Rozhledy*, Nos. 11 and 12.

SRDÍNKO, O. 1917a. [The sex of children from twin and triplet births.] *Lékařské Rozhledy*, Nos. 11 and 12.

SIEGEL, F. W. 1916. Bedeutung des Kohabitationstermin für die Befruchtungsfähigkeit der Frau und für die Geschlechtsbildung des Kindes. *Münch. med. Wchnschr.*, Vol. 63, pp. 748-750.

STEVENSON, T. H. C. 1920. Eighty-Second Annual Report, Registrar-General 1919. *London* (H. M. Stationery Office).

STIEDA, W. 1875. Das Sexualverhältnis der Geborenen. *Stat. Mitteil.*, 5 Heft.. Strassburg.

TAUSSIG, F. J. 1936. Abortion. Spontaneous and Induced. *St. Louis* (C. V. Mosby).

U. S. DEPARTMENT OF LABOR, CHILDREN'S BUREAU. 1934. Maternal Mortality in Fifteen States. *Washington, D. C.* (U. S. Government Printing Office).

VIGOR, H. D., and G. U. YULE. 1906. On the sex ratios of births in the registration districts of England and Wales, 1881-90. *Jour. Roy. Stat. Soc.*, Vol. 69, pp. 576-582.

WETTERDAL, P. 1927. Two questions pertaining to the sex ratio in newly-born infants. *Acta Obstet. et Gynec.*, Vol. 6, pp. 59-66.

WINSTON, S. 1932. Some factors related to differential sex-ratios at birth. HUMAN BIOLOGY, Vol. 4, pp. 273-279.

WITSCHI, E. 1934. Genes and inductors of sex differentiation in amphibians. *Biol. Rev.*, Vol. 9, pp. 460-488.

WOLDA, G. 1927. Akklimatisierung und Deklimatisierung II. Analyse der holländischen Geburtsperiodizität auf Grund ornithologischer Untersuchungen. *Genetica*, Vol. 9, pp. 157-216.

WOODS, F. A. 1906. The non-inheritance of sex in man. *Biometrika*, Vol. 5, pp. 73-78.

PERSONAL APPEARANCE AS RELATED TO SCHOLASTIC RECORDS AND MARRIAGE SELECTION IN COLLEGE WOMEN

BY S. J. HOLMES AND C. E. HATCH

Department of Zoology, University of California

ACCORDING to Darwin's theory of sexual selection, beauty has played an important rôle in selective mating both in human beings and in the higher animals below man. As a rule Nature is not given to indulging in useless frills and, unless she has departed from her customary utilitarion ways, it seems probable that the selection of mates on the basis of aesthetically pleasing appearance has contributed somehow to the biological welfare of the species. Darwin's theory of sexual selection has elicited no small measure of adverse criticism into the merits or demerits of which we shall not here enter. But whatever part aesthetic appreciation may have played in the mating of animals below man, its influence in the marriage selection of human beings has never been questioned.

The biological effects of selection for beauty obviously depend upon the characteristics with which beauty is associated. There has been a good deal of theorizing on this subject but almost no inductive investigation. The topic has usually been discussed from a purely *a priori* standpoint. We do not even know that, on the average, beautiful women are chosen as wives more often than homely ones. Probable as such a selection may seem, there has been almost no effort to ascertain whether or not it actually occurs. As to the characteristics, mental and physical, that commonly go along with beauty, we have only the evidence derived from casual observations and opinions based on *a priori* judgments.

MATERIAL

We shall not attempt to review the various opinions concerning the biological or psychological correlates of beauty, but will confine ourselves to describing a modest attempt to find out, for one class of the

population, how beauty is related to success in intellectual pursuits and later to chances of marriage. It would be of much interest to determine what relationship exists between beauty and native intelligence. A face that betrays that the mind behind it is an intellectual blank would hardly be regarded as beautiful however regular might be its features. To a certain extent indications of intelligence are marks of beauty. So also are facial expressions that give the impression of good health, cheerfulness, and kindly disposition. In so far as intelligence is correlated with good health and natural vigor one would expect that beautiful women would be somewhat above the average in intellectual gifts. But the actual evidence on the subject is very inconclusive. In the present investigation, since scores in intelligence tests were not available for the individuals studied, we have endeavored to ascertain the relation of beauty to scholastic grades in a fairly large group of over 600 women students of the University of California. In order to obtain a sufficient basis for scholastic rating the study was confined to students who had at least two years of college work. The grades of students were obtained from the office of the Registrar. The scholarship average was determined by calculating the ratios of grade points to units. In the system of grading employed at the University of California the grade of A receives a credit value of 3 points per unit; grade B receives 2 grade points; and grade C only 1. A D receives no grade points; an E or an F takes away 1. All students had from 60 to over 100 units to their credit.

Of course, grades are not an accurate measure of intelligence, but in the absence of intelligence tests they formed the best index available. As many studies have shown, scholastic records and scores on intelligence tests give a fairly high positive correlation. Perhaps one may safely assume that, other things equal, the higher grades are made by the more intelligent students, but one cannot be sure that other things really are equal. One factor which might disturb whatever natural connection there might be between personal beauty and the ability to make a good scholastic record is the circumstance that beauty itself might prove to be a handicap to scholarship because the more beautiful girls are more apt to be distracted by social engagements. Their plainer sisters, being less in demand, have more time for scholastic pursuits and might therefore make better records. Unfortunately the influence of this factor cannot be measured.

RATING FOR BEAUTY

In rating women for beauty it was thought desirable to employ only a few categories. Students were classed in four groups: I beautiful, II good looking, III plain, and IV homely. The women classified were those with whom the observer was not personally acquainted. They were observed in classes and their names were obtained from the lists of assigned seats. Each class was visited from six to ten times, and if subsequent ratings did not agree with the one first made the record was discarded. Those who seemed to belong to no definite group or who seemed to be on the borderline between two classes were also discarded, leaving only those who seemed to the observer to fall definitely within a given class. The greatest stress was laid upon beauty of face, although the general impression given by stature and hair had a slight influence. Persons showing definite indications of ill health were not rated. There was an attempt to minimize the effect of expression on judgments of physical beauty by rating women only when their facial muscles were in repose. If the student was seen talking or laughing a rating was not given that day. Only women belonging to the Caucasian race were considered and none was included over thirty years of age. Clothes and general make-up were given as little consideration as possible.

It is evident that observers have their own standards of beauty and that ideals vary as a result of education and environment. Nevertheless there is a fairly broad basis of agreement as to the types of women rated as beautiful or ugly. The artist in recognizing and depicting beauty has helped to create a common standard. Through works of art, pictures in magazines, and by moving pictures, people have been educated to regard certain types as beautful. There are, of course, differences of opinion over the rating of certain individuals. In order to find out how the personal equation is apt to influence ratings for beauty, groups of students were independently rated by three diffenent observers after a preliminary discussion of the criteria used in classification. One judge was a professor who rated 20 women in his class at the beginning of the semester before he had a chance to be influenced greatly by their personalities. The second judge was an art student who rated 25 and the third was a student who rated 120. The verdicts were as follows:

Judge	*Number rated*	*Differences in rating*	*Per cent of agreement*
1	20	0	100
2	25	1	96
3	120	6	95

Apparently this indefinable quality we call beauty represents something about which the judgments of different people show a fair amount of agreement. The few cases about which the ratings of the judges differed were not used in the material investigated.

COLLEGE GRADES AND BEAUTY

Having divided the individuals observed into four classes representing different degrees of beauty, the next step was to compare the average grades of the several groups. The grade point averages of the entire group are as follows:

	Beautiful	*Good looking*	*Plain*	*Homely*
Average	1.42	1.44	1.56	1.61

These results indicate that however beauty may be related to intelligence it apparently has an inverse relation to the attainment of high scholarship records by college students. It occurred to us that these results might be due largely to selection instead of to any direct connection between beauty and intelligence. The grade point average of seniors is higher than that of juniors, and the average of the graduate students is higher than that of seniors. If the more beautiful girls failed to go on to advanced work to a greater extent than their less favored sisters, either because they married or for any other reason, we might obtain an increased proportion of the plainer students among those with higher average grades. That a selection of this sort probably occurs is shown by grouping our statistical data in another way. If we take each class, juniors, seniors, and graduates separately and find how the grades of beauty are distributed within each of these classes, we find some rather striking facts. The data on the distribution of the various grades of beauty within each class are shown in the following table:

Distributions of ratings for beauty by class

		I BEAUTIFUL	II GOOD LOOKING	III PLAIN	IV HOMELY
Juniors	Number	25	108	68	17
	Per cent	11.4	49.5	38.9	7.79
Seniors	Number	33	84	100	27
	Per cent	13.5	34.4	40.9	11.0
Graduates	Number	16	44	82	39
	Per cent	8.83	24.3	45.3	21.5

The per cent of girls adjudged plain or homely is lower in the juniors than in the seniors and lower in the seniors than in the graduates. And correlated with this trend is the fact that the percentage of girls adjudged beautiful is lower in the graduates than in the juniors. The slightly higher percentage of beautiful girls among the seniors may be only a chance result due to the small numbers involved. In order to obviate in a measure the influence of chance distributions in small samples we have combined the beautiful and good looking in one group and the plain and homely in another. There are many cases in which it is difficult to decide whether a given individual should be rated as beautiful or good looking, and as plain or homely. For a study of how beauty functions, a grouping of women as either good looking or not good looking is a natural one to make because this distinction might be considered as frequently determining choice in marriage and decisions in many other relationships. When we combine the four groups in two categories and calculate the percentages in each of the three classes of students, juniors, seniors, and graduates, the trend which we have mentioned comes out more sharply. The results are as follows:

	Group I and II	*Group* III and IV
Juniors		
Number	133	85
Per cent	61.0±2.2	39.0±2.2
Seniors		
Number	117	127
Per cent	47.9±2.1	52.1±2.1
Graduates		
Number	60	121
Per cent	33.1±2.3	66.8±2.3

A calculation of the probable errors of these percentages shows very definitely that with the exception of the seniors the differences in the percentage of good looking and the plain cannot reasonably be regarded as a chance result of random sampling. It shows also that the differences between the several classes, juniors, seniors, and graduates, cannot be due to chance alone. Interpret them how we will, the differences show a high degree of reliability from the standpoint of the statistician. One may explain these differences in several ways. It might be contended that the more beautiful find greater difficulty in successfully carrying on collegiate work either from natural ineptitude or from too many distracting engagements. It might be contended that the lower percentage of the good looking among the more advanced students is due to the subtle influence of age on standards of rating, although no individual over thirty years of age was included in the investigation. The effect of this factor we believe is relatively small. Or again, we might conclude that the more beautiful women are not so apt to go for advanced study as those with less personal attraction. We are inclined to ascribe a good deal of importance to this factor. According to this interpretation, one would expect to find greater differences between graduates and seniors than between seniors and juniors. This is, in fact, what occurs, but the differences between graduates and seniors is relatively less than might have been anticipated. It is only a little greater than the differences between the juniors and seniors. It was thought that this fact might in part be due to the relatively large number of students who have come to the university from other institutions for their last year and whose transfer represents about as great a break in the continuity of their work as the transition from senior to graduate status, but a study of the distribution of grades for beauty in the transferring students gave little support to this supposition. Not improbably the more comely types do not continue in college even before graduation to so great an extent as the plainer students.

In order to eliminate so far as possible the influence of selective removal on the relation between ratings for beauty and scholarship grades we have made a tabulation of the scholastic records within each class separately. The results which are given in the following table indicate that within the limits of each class as well as in the total number there is a tendency for scholarship grades to increase as the ratings for pulchritude diminish.

Grade point averages as related to ratings for beauty

CLASS	BEAUTIFUL	GOOD LOOKING	PLAIN	HOMELY
Juniors	1.16	1.33	1.45	1.58
Seniors	1.56	1.45	1.52	1.55
Graduates	1.53	1.70	1.70	1.67
TOTAL	1.42	1.44	1.56	1.61

The manifestation of this tendency, which is somewhat irregular owing probably to chance fluctuations in small number, is brought out more clearly by combining the first two (beautiful and good looking) and also the last two (plain and homely) groups. The percentages for the combined classes are as follows:

Average grade points according to ratings for beauty

	GROUPS I and II	GROUPS III and IV
Juniors	1.30	1.47
Seniors	1.48	1.52
Graduates	1.65	1.68
TOTAL	1.43	1.57

These data show a consistent trend throughout. In both the good looking and the plain group the grade point averages increase as we pass from the junior to the graduate class. For each class the figures show that the plain group has a better scholastic record than the better looking group. When we compare the differences in scholastic record associated with class with the differences associated with the two grades of personal appearance we find that personal appearance has about as great an effect upon scholastic records as does length of sojourn in college. We apparently have to do with two very different sets of influences in determining grade point averages. If the more beautiful girls leave college more often than the plainer ones the effect might be to raise the grade point average somewhat, but this factor is probably a very minor one. The rise of grade point averages after the freshman year is probably mainly the result of the elimination of poor students and the develop-

ment of more serious interests and improved habits of study in those who remain. There is some indication that the unfavorable effect of beauty on scholarship is greatest in the juniors, less in the seniors, and least in the graduates. If this unfavorable effect is due to the greater distractions of the more attractive girls it is not unreasonable to suppose that the more mature students should be less affected than the younger ones.

It would be desirable to ascertain how beauty is related to scholastic records or the results of intelligence tests in other groups, such as students in grammar schools, high schools, and the first two years of college. Such investigations carried out on a scale sufficiently extensive to give statistically reliable results are very laborious, but it is only by a statistical analysis of large samples of the population that one can arrive at well grounded conclusions as to the biological functioning of beauty in modern life.

This paper represents an attempt to gain some real knowledge of the rôle played by personal appearance in a small selected group of the population. The findings indicate that personal appearance has a rather important effect upon the careers of young women attending college. It probably influences the duration of their college careers, the character of their social life, and apparently the quality of their scholarship. Possibly good looks may cause the loss of some grade points, but we are prepared to concede that the other experiences gained may more than counterbalance this loss. That personal appearance has much to do with the happiness of girls and young women is obvious. It has much to do with a woman's success in many relationships. The time, energy, and money spent upon the enhancement of personal beauty are incalculable. And probably no one would deny that this vast expenditure somehow pays.

SEXUAL SELECTION

We commonly assume that beauty plays an important part in selection in marriage but, plausible as this conclusion seems, it can scarcely claim to be demonstrated. The only way in which to find out how beauty influences marriage selection is to make a comparison of the mated and unmated with due allowance for age and other circumstances in several typical samples of the population. Until we have some quantitative studies on how sexual selection is actually working out we cannot

be said to have any real knowledge of this possibly very important factor in human evolution.

There have been several studies of assortative mating in relation to stature, color of eyes and hair, education, and other characteristics, and there have been a few compilations of results of questionnaires on desirable qualities in mates, but the actual workings of sexual selection in man is an almost completely neglected field. The valuable study of Heymons and Wiersma on the differences between the married and the unmarried in regard to several traits of mind and character has been followed by no similar investigations. The rôle of beauty, however, was not especially studied by these writers.

About the only study on the relation of beauty to marriage selection that we could find was made by Miss C. F. Gilmore and described in an unpublished thesis for the Master's degree at the University of Pittsburgh. This paper was referred to in a paper on "Marriage Selection" (1924)[1] by Dr. R. S. Johnson and was discussed briefly in the first edition of Popenoe and Johnson's *Applied Eugenics*, but no mention of it is made in the revised edition of this book. The study was based on the class of 1902 of the Southwestern State Normal School of Pennsylvania. The girls were rated for beauty on the basis of 100. It was found that 70 per cent of the prettiest girls (rated 80 and over) were married and that in general the marriage rate fell as ratings for beauty were low, although more were married in the 50+ class than in the 60+ class. Unfortunately the numbers upon which the percentages were based are not given in any of the references to this work. Popenoe and Johnson refer to the results as "interesting, though far from conclusive." In the absence of any further information, we shall have to be content with this verdict.

We have endeavored to obtain some further light on the functioning of personal appearance in our group by ascertaining the proportions of those in the several classes who married since the time at which they were rated. We had started to collect information by sending inquiries concerning marriage to the students rated, but owing to the fortunate circumstance that a thorough canvass of all the alumnae of the University of California was being made in connection with the issue of the *Golden Book of California*, which aimed to include data on the marriages of all graduates of the university, it was decided to give up sending questionnaires and to avail ourselves of the information collected for this volume. Now that the *Golden Book of California* has been published we have compiled the number of marriages of women in each

---

[1] *Proc. First Nat. Congr.* on Race Betterment, 515-532, 1914.

of the four classes used in the ratings used for beauty. The results came out with a decisiveness and a degree of regularity surpassing all expectation. The findings are collated in the following table:

Relation between ratings for beauty and marriage in college women

	GROUPS			
	I	II	III	IV
Numbers	74	246	242	80
Per cent married	34.00	28.05	15.66	11.25

The results show clearly that the percentages of women graduates who marry within a few years after leaving college regularly decrease as the ratings for beauty become lower. Granted that these ratings are very inaccurate and based on subjective and not very clearly definable criteria, they nevertheless show a striking agreement with the judgments of the gentlemen who selected wives from the group investigated.

There is also, as we have seen, a fair correlation between ratings for beauty and evaluations of scholastic work by the university instructors who assigned grades. Perhaps the more prepossessing young women may have obtained relatively low marks because of the reactions of people responsible for the distracting effects of popularity. But, however the relations may be brought about, the judgments of the persons who classified the young women as to their beauty have a significant correlation with objective facts.

The relation of beauty to marriage selection, shown by a fairly large sample of over 600 college women is probably indicative of the trend of marriage selection in the general population. It seems likely, however, that in the college group there is relatively more discrimination on the basis of beauty than among the rank and file of women. In a previous study by one of the present writers it was shown that only about 55 per cent of the women graduates of the University of California ever marry. If most women marry, as they do in ordinary walks of life, most of the plain and a fair share of the homely will be chosen. The fact that a relatively smaller proportion of college women marry makes possible a more discriminating selection within the group, and may therefore tend to emphasize the relation between beauty and marriage selection which our study reveals.

Since beauty is, to a certain extent, correlated with low grades in college, and since the more prepossessing young ladies are more apt to

marry after graduation than the plainer ones it might be inferred that scholastic records of the married would fall below those of the unmarried. Since it cannot be assumed that this conclusion necessarily follows we have investigated the subject by tabulating the grade point averages of the married and the unmarried. The undergraduates were mostly members of the classes of 1933 and 1934. Owing probably to the financial depression the marriage rates of these classes were unusually low. Perhaps this circumstance has caused the character of marriage selection to be somewhat different from what it would be in normal times. Our sample of the married represents the first selections made from the group. How the average would be affected by subsequent marriages cannot be foretold with certainty, but in respect to scholarship it would probably be closer to the mean of the whole group of alumnae.

In a previous investigation of marriage selection and scholarship by Bolin and Holmes,[2] based on the entire number of alumnae up to 1910 it was found that the scholastic grades of the married and the unmarried differed by a very small and statistically non-significant figure. The extensive data obtained covered within a small percentage all the marriages that would occur in the group. Our present data differ from those collected for the previous study in including only those marriages contracted soon after graduation (except for the relatively few students who were married while in college), and the results are somewhat different in that they indicate that the scholastic records have a slight negative correlation with likelihood of marriage. The grade point average of the 140 married alumnae was 1.42, whereas that of the unmarried was 1.53. A comparison of the records of the separate classes, juniors, seniors and graduates, showed much the same relations for each group as for the entire number. The data for the individual classes are as follows:

Grade point averages of married and unmarried graduates

	Married	*Unmarried*
Juniors (49)*	1.21	1.41
Seniors (55)	1.49	1.51
Graduates (36)	1.55	1.70

*Numbers married, in parentheses.

[2] *Jour. Heredity*, 18, 253-255, 1927.

The differences in grade point average between the married and the unmarried are not large, but they are all in the same direction. The results are about what might be expected in the light of the previous findings.

One may hypothecate various reasons for these facts. It cannot be assumed that scholarship causes women to be less attractive to the male sex. It may lead women to be more discriminating in their choice of mates, or it may go along with other qualities, physical or mental, which adversely affect the inclination or the opportunity to marry. Perhaps a young woman is more liable to marry if her interests in intellectual matters are not too serious. That the more comely young women fall somewhat below the average in scholarship while in college may of course be due, not to lack of native intelligence, but to the scholastic drawbacks of greater popularity. If so, our results would not be indicative of any dysgenic effects of the relations discovered.

What relation, if any, there may be between beauty and fertility remains to be ascertained. We do not anticipate a numerous progeny from the group investigated, but we are saving the records in the hope that at some future time they may possibly shed some small amount of light on this problem.

SUMMARY

A study of scholastic records in relation to ratings for beauty in over 600 women students of the University of California showed that scholastic averages diminished as ratings for beauty are increased.

Ratings of the same individual for beauty by different observers showed a fairly high percentage of agreement.

The proportion of women rated as beautiful or good looking decrease with years spent in college, being highest in juniors, lower in seniors, and least in graduates. This fact probably results in part from selection.

A study of the marriages occurring in the classes rated for beauty showed that as beauty decreased the percentages married also decreased, thus affording evidence that beauty plays a very important rôle in marriage selection within the class of individuals studied.

In each class, juniors, seniors, and graduates, the grade point averages of the married fell below those of the unmarried.

TWO UNLIKE EXPRESSIONS OF SYMMETRY OF FINGER-TIP PATTERNS

BY HEINRICH POLL

Berlin

THE symmetry of dactyloglyphics[1] is not comparable to the rigid bilateral symmetry involving form and general structure of the digits. Finger-tip patterns of quite different types, for example an arch and a whorl, occur frequently on homonymous digits of right and left hands in one individual. Notwithstanding the lack of a consistent symmetry of the ordinary kind, the distributions of pattern types manifest certain trends of symmetry when adequate groups of subjects are analyzed statistically. It might be expected that such trends would be correlated with the antimeristic

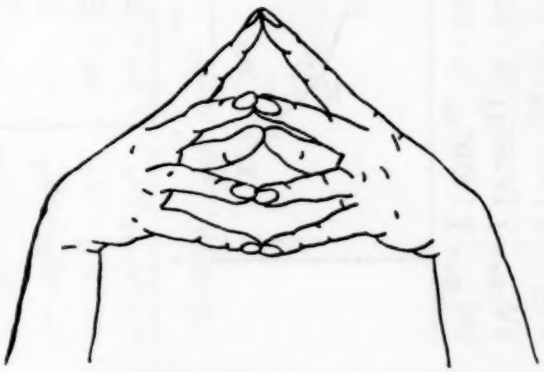

FIG. 1. SYMMETRY OF THE HANDS ACCORDING TO THE ORDINARY ANATOMICAL CHARACTERISTICS

similarity of other anatomical features of the hands (Fig. 1), but this is not the case in the large majority of races thus far studied. While in their pattern-type frequencies digits II, III and V do conform to this

[1] The dermatoglyphics of finger tips, loosely called "finger prints".

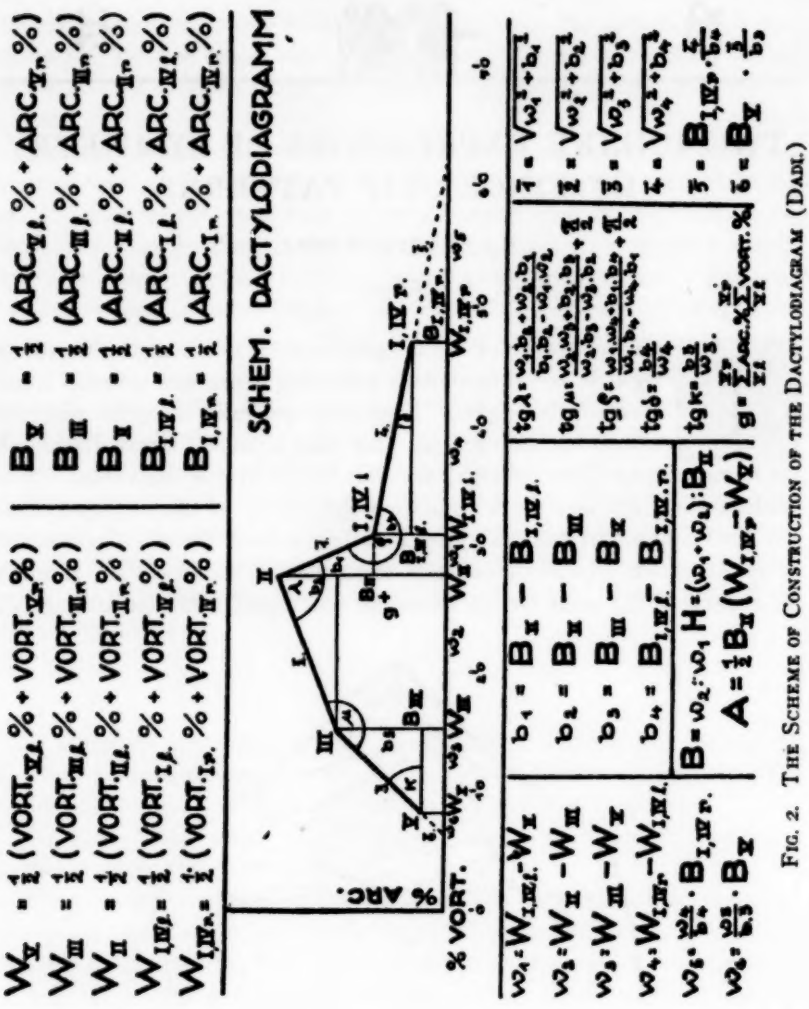

FIG. 2. THE SCHEME OF CONSTRUCTION OF THE DACTYLODIAGRAM (DADL.)

expectation, the thumb and annular of the same hand are more closely related than are the right thumb and left thumb, the right annular and left annular. To the distinctive association of digits I and IV the writer ('34) has given the name *pair-group rule*. The purpose of the present paper is to demonstrate, as a contrast to the expression of the rule in various widespread human populations, its exceptional failure in peoples of western, central and southern Africa.

A method adapted to the study of the symmetry relations is the dactylodiagram (hereafter abbreviated to dadi.), a method suggested in 1934 by Poll. The construction of the dadi. is shown in Fig. 2, and to illustrate its application reference may be made to an actual series, selecting for the purpose the classical records of 500 Englishmen published by Galton (1892).

The dadi. of this English series, Fig. 3, shows the status of each digit in reference to the frequencies of arches and whorls. The digits are arranged in the order of increasing whorl frequencies, whorls being plotted in the abscissa and arches in the ordinate. It will be noted that

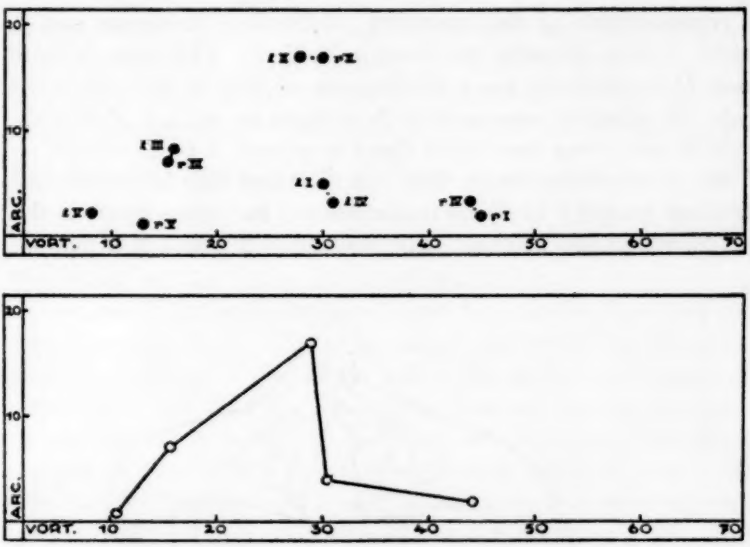

FIG. 3. DADI. OF 500 ENGLISHMEN, BASED ON DATA FROM GALTON, 1892, ILLUSTRATING CONSTRUCTION OF THE DADI. IN A TYPICAL INSTANCE OF VALIDITY OF THE PAIR-GROUP RULE

Upper figure shows the arch-whorl frequencies of the ten digits, indicated by coarse dots. Note the bilateral pairing of values for digits V, III and II, and the contrasting grouping of the values left IV/left I and right IV/right I. The arithmetic means of the pairs and groups of values are indicated by fine dots, and on the dadi. each corresponds to the mid-point of the actual distance between. *Lower figure* is the completed dadi., in which the arithmetic means of the three pairs and two groups are joined by continuous lines to form a curve.

FIG. 2. THE SCHEME OF CONSTRUCTION OF THE DACTYLODIAGRAM (DADI.)

right and left hands present closely related *pairs* of values for homonymous digits in the instances of V, III and II. The values of digits I and IV resolve into two quite different couplings, specially designated *groups* for distinction from the bilateral pairings of corresponding digits. The dadi. shows clearly that the left thumb and left annular form one group (hereafter termed the IV/I left group) and the right thumb and annular another (IV/I right group). Completion of the dadi. involves merely the joining of the arithmetic means of each two neighboring values; the curve is thus carried in order through pairs V, III and II, into group IV/I left, and ending with group IV/I right.

The symmetry relations are those shown in Fig. 4, rather than the ordinary symmetry of Fig. 1, and this example of the pair-group rule is representative of the symmetry relations in European and Asiatic races. A few instances are listed in Table 1. The value is the difference, D, between the sums of distances of thumbs and annulars in the dadi., the minuend representing these digits as pairs, ΣP, and the subtrahend combining these same digits in groups, ΣG: $D = \Sigma P - \Sigma G$. With an accurately drawn dadi. the distances may be determined with sufficient accuracy by direct measurement; the values given in the table are derived in this manner. The summands ΣP and ΣG may be com-

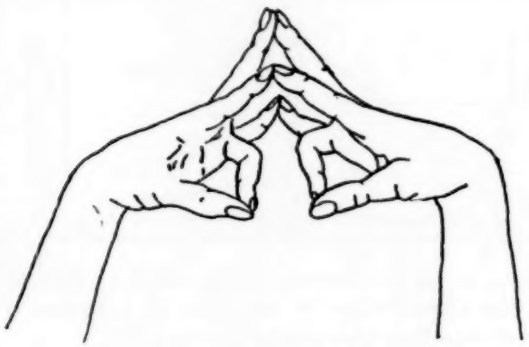

FIG. 4. POSITION OF THE FINGERS ACCORDING TO THE CORRESPONDENCES OF THEIR DACTYLOGLYPHICAL VALUES (BASED ON FREQUENCIES OF PATTERN TYPES)

Digits V, III and II form *pairs*, while the thumb and annular of the left hand and the thumb and annular of the right hand form respectively the left and right IV/I *groups*.

puted also as the hypotenuses of right-angled triangles, with the differences of arches as ordinates and the differences of whorls as abscissae:

$$\Sigma P = \sqrt{(A_{III}-A_{rIV})^2 + (W_{rIV}-W_{III})^2} - \sqrt{(A_{II}-A_{rI})^2 + (W_{rI}-W_{II})^2}$$

$$\Sigma G = \sqrt{(A_{II}-A_{III})^2 + (W_{III}-W_{II})^2} - \sqrt{(A_{rI}-A_{rIV})^2 + (W_{rIV}-W_{rI})^2}$$

The figures obtained are to be taken as absolute values, the differences being computed without regard to their positive or negative signs.

To provide proof of the statistical significance of the pair-group rule in a standard case the following tests have been applied to a series of 3000 individuals (criminals of Hamburg, Poll, '34a). The difference and its mean average error, determined in the usual way, are $\Delta \pm \mu\Delta = 21.67 \pm 2.35$ per cent. Since the value is nearly ten times larger than its mean average error the difference must be accepted as significant and real. Now measuring the validity of pair-group rule not in terms of the difference between ΣP and ΣG but in the relation $R = \frac{\Sigma P}{\Sigma G}$ it is found that $R \pm \mu R = 3.32 \pm 0.60$. Since the relation is 5.5 times larger than its error the significance is again of high order. As another test of accuracy of the figures the whole material has been divided into 30 random lots of 100 individuals each, and for each lot the above computations have been made. The differences in the 30 lots are distributed in a fair binomial curve. In one lot only is the sum of the thumb-pair and annular-pair less than the sum of the right and left thumb-annular groups, and this with the minute difference of 1.8 units. Twenty-nine lots are positive in respect to the expression of the pair-group rule. The mean probability that this result is reliable for similar observations in general is determined by the formula of van der Waerden ('36), where n = number of cases, h = number of positive observations and k = number of negative observations:

$$m = \frac{n+1}{n+2} \pm \frac{1}{n+2} \sqrt{\frac{(h+1)(k+1)}{n+3}}$$

$$m = 93.75 \pm 4.22\%.$$

The probability is here 7.4 times greater than the error tripled, and the reliability of the observations is thus established.

The present study, dealing especially with conditions in African peoples, enlarges on the communication presented before the Congrès

International des Sciences Anthropologiques et Ethnologiques, London, 1934, when for the first time notice was directed to an instance of failure of the pair-group rule.

The 42 Hottentots reported by Fleischhacker ('34) supplied the first case drawing attention to this circumstance. The dadi. for the series (Fig. 5) may be used in explanation of the special characteristics

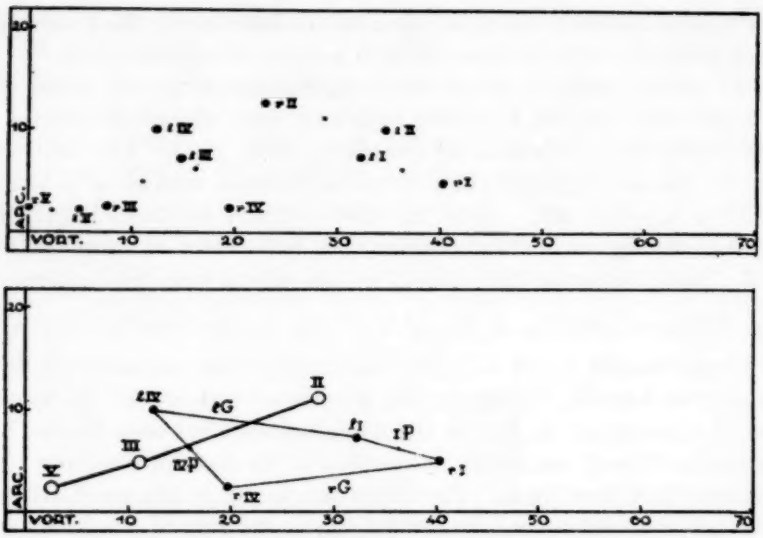

FIG. 5. DADI. OF 42 HOTTENTOTS BASED ON DATA FROM FLEISCHHACKER, '34, ILLUSTRATING CONSTRUCTION OF THE DADI. IN A CASE LACKING THE PAIR-GROUP RULE

Upper figure gives individual values for the ten digits. *Lower figure* shows the dadi. curve drawn, as in Fig. 3, in a continuous line uniting the arithmetic means of the V, III and II pairs, but digits I and IV are accorded special treatment. With a fine line left I and right I are joined as a pair, as are left IV and right IV; the left IV and left I are united as a group, and the right IV and right I likewise, thus enclosing a quadrilateral figure. The sum of the distances of these digits considered as pairs (line l P + line IV P) is smaller than the sum of the distances involved in considering them as groups (line l G + r G). In other words, $\Sigma P < \Sigma G$ and the pair-group rule is void. (For further analyses of the dadi. the curve should be completed by joining pair II to the arithmetic mean of pair IV, and that to the mean of pair I, as in Figs. 6 and 7, using dotted lines for distinction from the usual dadi. in which IV and I are related to each other as groups. But for simplicity and in view of the small number of subjects the lines are omitted in this example.)

and interpretation of the dadi. in such departures from the usual symmetry. In the upper section of the figure the single points for the ten digits are marked and the arithmetic means of neighboring values are indicated. In the lower section a line is drawn connecting these means for pairs V, III and II, according to the ordinary scheme as previously explained. The values of left IV and left I are united by the line l *G* representing the left group, and right IV and right I are similarly joined as the right group. To prove whether the pair-group rule is valid lines are now drawn to join the values of pair I (line I *P*) and pair IV (line IV *P*), thus completing a quadrilateral figure. Add the opposed sides of this quadrilateral. If, as in the present dadi., I *P* + IV *P* = Σ *P* < r *G* + l *G* = Σ *G* the pair-group rule is lacking; when Σ *P* > Σ *G* the pair-group is valid. It may be fixed arbitrarily that the rule is lacking if Σ *P* = Σ *G*.

To mark the difference between the two kinds of symmetry as expressed in the dadi. the two segments of the curve joining the means of pairs II, IV and I may be drawn as dotted lines (Figs. 6 and 7), rather than with the continuous lines which in the usual circumstances join pair II, group IV/I left and group IV/I right. These lines are omitted in Fig. 5 in the interest of simplicity and on account of the lesser reliability of a series composed of only 42 individuals. The symbols of the angles λ, ζ and δ, of the distances W_1, W_4 and W_5, and $\bar{1}$, $\bar{4}$ and $\bar{5}$ may be distinguished from the analogous values of the original dadi. by the addition to each of an accent mark, signalizing their different meanings.

Though the case of the Hottentots alone may not be thoroughly convincing evidence of a substantial deviation from the common symmetry, other materials are available which show that the pair-group rule is likewise void in certain other African peoples. The important publication of Dankmeijer ('34) supplies records on 207 Efé pygmies from Itoeri Forest in central Africa. Dr. Margarethe Weninger ('36) gives figures for 32 Bushmen, a small series yet an important racial and geographical sample. Finally, data for 87 "pygmies, pygmoids and negrillos" from the upper Congo are made available in the interesting book of Mutrux-Bornoz ('37). Converting the original figures into dadi. form (Fig. 6), it will be seen that all three series agree in the absence of the pair-group rule, as before noted in the Hottentots.

Two points of weakness in these last data are to be noted. With the exception of the Bushmen (20 males, 12 females) the sexes are not

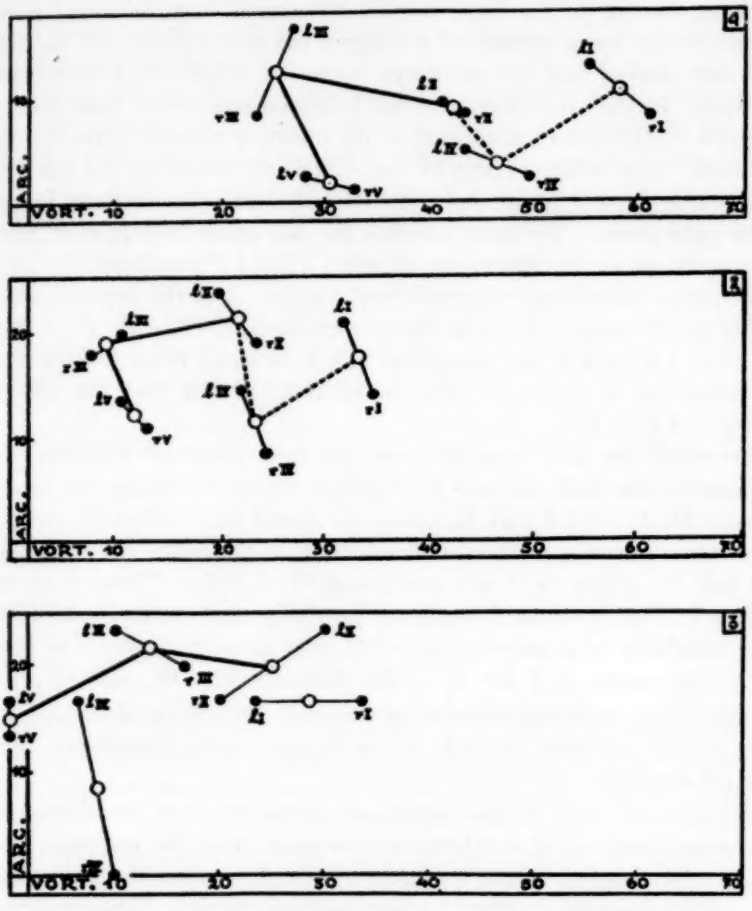

FIG. 6. DADIS. OF CENTRAL AND SOUTHERN AFRICA, PAIR-GROUP RULE LACKING

[1] 87 pygmies and negrillos—85 exact number used—of the upper Congo (data from Mutrux-Bornoz, '37). [2] 207 Efé pygmies of Central Africa (data from Dankmeijer, '34). [3] 20 male and 12 female Bushmen (data from M. Weninger, '36). The dotted lines, explained under Fig. 5, are omitted in the Bushmen dadi. in consideration of the small size of the series.

treated separately by the authors. It is therefore impossible in this material to determine the sexual differential in the dadi., for comparison

with peoples wherein the pair-group rule is valid and in which it has been shown (Poll, '35) that females present a shorter thumb-annular distance than males of the same biotype. In view of this condition proof of significant deviations requires larger series of females than of males. Second, the numbers of subjects are small, of course very far below those representing the European populations, and proof of significance must rest largely upon the coincidence of findings in the several independent collections. The reported distinction, even based on small numbers and thus involving a correspondingly large statistical error, will at least serve to direct attention to lack of homogeneity in the human species of so fundamental a character as symmetry.

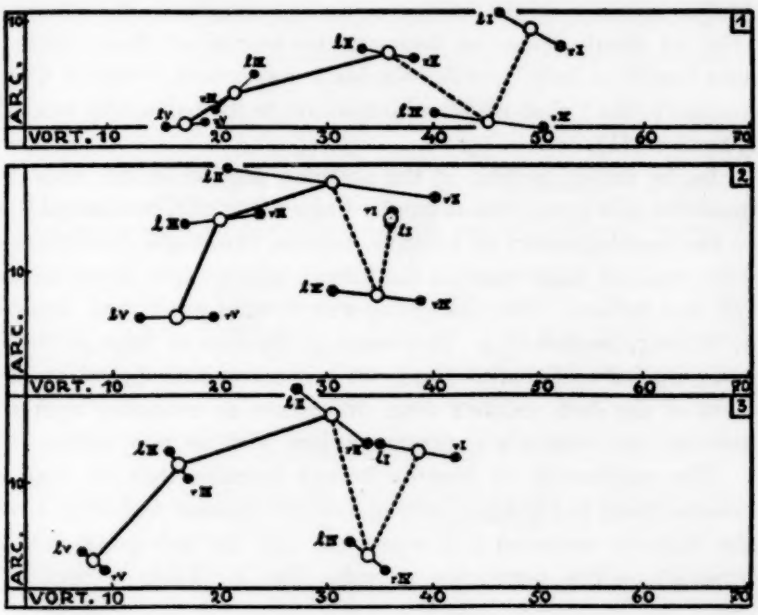

FIG. 7. DADIS. OF WESTERN AFRICA, PAIR-GROUP RULE LACKING

[1] A composite of 100 Liberian soldiers from Cummins, '30, reduced by incomplete prints to 92.3, and 154 natives of the northern coast of the Guinean Gulf, Poll. [2] 72 Jamaican blacks, and [3] 118 Jamaican browns, both from Davenport and Steggerda, '29. The dotted lines, as explained before, are used to indicate the present coupling of the annulars as a pair and the thumbs as a pair, rather than in the generally prevailing left and right IV/I groups.

Following up these observations, material from other regions of Africa has been investigated, the results being shown in dadis. (Fig. 7) and in Table 1 (Section III). West African Negroes[2] exhibit failure of the pair-group rule, in common with the central and northern African populations. Although the *D* value is small in this case, perhaps being influenced by the pooling of figures from different sources, the reliability of the demonstrated lack of the pair-group rule is reasonably assured owing to the larger body of material and its restriction to males.

Further light on the question is obtained from the figures for "blacks" in Jamaica (Davenport and Steggerda, '29), where again the pair-group rule is void (Fig. 7; Table 1, Section III). In the Jamaican "browns" it is to be seen that cross-breeding does not obliterate this African character in the relation of the thumb and annular for the dadi. (Fig. 7) clearly shows an homonymous pairing of these digits. The same condition holds true for the black and brown people of Cuba[3], in contrast to the Cuban whites who conform to the pair-group rule (Table 1, Section III).

In the known peoples of the northern portion of the African continent the pair-group rule is valid. Falco ('17/'18), in a valuable paper on the dactyloglyphics of Libyans, follows Ottolenghi in distinguishing three types of inhabitants in the Libyan region: *tipo negro, tipo arabo* and *tipo berbero.* The pair-group rule is valid in all three types (Fig. 8; Table 1, Section IV). In a smaller collection of Tebu of the Cufra oasis, studied by Sabatini ('34), the pair-group rule applies, though the form of the dadi. exhibits some differences as compared with Falco's material, and especially under comparison with the *tipo arabo.*

The publication of Mutrux-Bornoz includes data on 109 insane subjects from Bagdad, and having this information regarding a population hitherto unknown it is now clear that the pair-group rule is adhered to by this population as well (Fig. 8; Table 1, Section IV).

---

[2] This statement is based on two collections, 100 Liberian soldiers (Cummins, '30) and 154 subjects mainly from the northern coast of the Guinean Gulf. For the latter material I am deeply indebted to Professor Kestner and Dr. Hans Streckfuss, who obtained the prints at my request.

[3] For prints of females of these groups I am indebted to the kindness of Dr. Israel Castellanos, Director of the Cabinete nacional de Identificacion de la Republica de Cuba. The figures on males were obtained from Dr. Harold Cummins, whose original prints had been received from the same source.

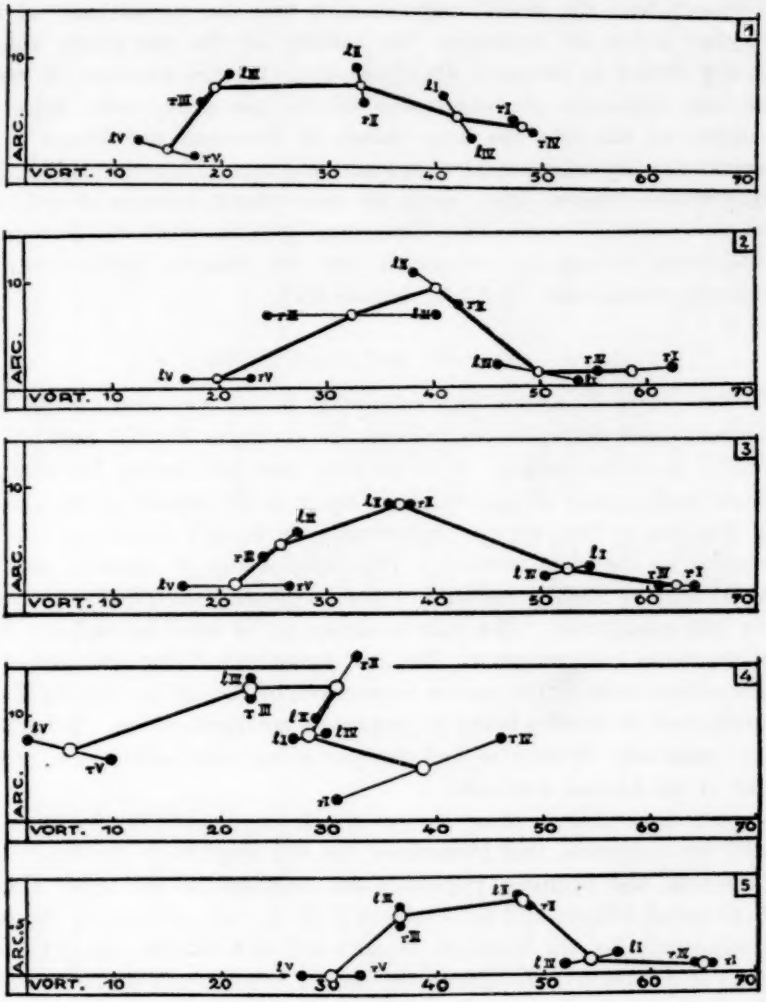

FIG. 8. DADIS. OF NORTHERN AFRICA, PAIR-GROUP RULE VALID

Dadis. 1, 2 and 3 are Libyans, data from Falco, '17/'18. [1] 250 subjects, tipo negro. [2] 250 subjects, tipo arabo. [3] 250 subjects, tipo berbero. [4] 104 Tebu di Cufra, data from Sabatini, '34. [5] 109 insane subjects, Bagdad, data from Mutrux-Bornoz, '37.

Although both the sexual representation and the special race[4] of this Bagdad series are unknown, the validity of the pair-group rule is clearly shown in the dadi. It is doubtful that the selection of insane subjects influences the expression of the pair-group rule, since the validity of the rule has been shown in Germans and Danes to be constitutionally independent of at least some mental disorders (Poll, '35; Blizenkrone Møller, '35). With the more recent addition of 200 male Rwala Arabs (Shanklin and Cummins, '37), in which the pair-group rule holds, it may be concluded that the Arabian characteristic is definitely established (Table 1, Section IV).

SUMMARY AND CONCLUSIONS

For all the European peoples studied in this connection it has been demonstrated that pattern frequencies of digits V, III and II are similar in corresponding digits of right and left hands, but that the thumb and annular of each hand are more closely related to one another in this respect than are the right thumb to the left thumb and the left annular to the right annular. This relationship of digits I and IV, which may be readily analyzed by the dactylodiagram (Poll), is termed the pair-group rule. The rule is shown to be valid beyond any limit of the mean average error. The pair-group rule holds true also in the Mongolian races, in the known populations of Asiatic Turkey, in Rwala Arabs, and as detailed below in peoples of northern Africa. It is therefore especially striking to find the pair-group rule void in the greater part of the African continent.

It is here shown, using figures which are already in the literature with one exception, that Hottentots, the Efé pygmies in central Africa, Bushmen, and pygmies, pygmoids and negrillos of the upper Congo, Negroes of Liberia and the Guinean Gulf do not conform to the pair-group rule. For the blacks of Jamaica and of Cuba the rule is likewise void, and since it fails also in the brown cross-breeds of both regions the indication is that these hybridizations have not effaced the African peculiarity. The several collections of material, in each of which the pair-group rule is void, amount to a total of 1147 individuals.

---

[4] I am indebted to the courtesy of the Imperial Irakian Embassy in Berlin for the information that the inhabitants of Irak as a whole comprise about four-fifths Arabs and one-fifth of other races. The probability is therefore rather high that by the selection of "pure race" (Mutrux-Bornoz, p. 64) a majority of Arabs is represented in the material obtained in the asylums of Bagdad.

TABLE 1

Listing of populations with indication in each of the validity or lack of the pair-group rule

The rule is valid in cases having a positive D value (Column 5), void when the value is negative. It will be seen that all the observed cases, 28 in number, confirm expectation in the behavior of the pair-group rule. With the application to this result of van der Waerden's formula for the mean probability that the assumptions regarding the rule are justified, $m = .97 \pm .03$.

1	1	2 NUMBER	3 COUNTRY, RACE	4 SEX	5 $\Sigma P - \Sigma G = D$	6 SOURCE	7 YEAR
I	1	86654	Denmark	m	+118	Bugge	1932
	2	8041	Germany	m	+105.5	Poll	
	3	2222	Holland	m	+114	Dankmeijer	1934
	4	24518	Norway	*	+122	Bonnevie	1924
	5	10000	Spain	m	+109	Oloriz	1908
	6	11000	Russia	m	+143	Semenowsky	1927
	7	38020	Germany	f	+ 39	Poll	
II	1	300	China	m	+ 13.5	Duffaux	1931
	2	1732	Japan	m	+ 44	Poll	
III	1	42	Hottentots		— 60	Fleischhacker	1934
	2	207	Efé pygmies		— 35	Dankmeijer	1934
	3	32	Bushmen	**	— 52	M. Weninger	1936
	4	87	Pygmies, Negrillos		— 42	Mutrux-Bornoz	1937
	5	254	Negroes, West Africa	m	— 5	Cummins (100); Poll (154)	1930
	6	72	Blacks, Jamaica	m	— 20.5	Davenport and Steggerda	1929
	7	118	Browns, Jamaica	m	— 29	Davenport and Steggerda	1929

TABLE 1 (*Continued*)

1	2 NUMBER	3 COUNTRY, RACE	4 SEX	5 $\Sigma P - \Sigma G = D$	6 SOURCE	7 YEAR
8	85	Blacks, Cuba	m	— 10.5	Cummins	MS
9	50	Browns, Cuba	m	— 31.5	Cummins	MS
10	100	Whites, Cuba	m	+ 14.5	Cummins	MS
11	100	Blacks, Cuba	f	— 49	Poll	
12	100	Browns, Cuba	f	— 82.5	Poll	
13	100	Whites, Cuba	f	+ 20	Poll	
IV 1	250	Libya, tipo negro	m	+ 16	Falco	1917/18
2	250	Libya, tipo arabo	m	+ 10	Falco	1917/18
3	250	Libya, tipo berbero	m	+ 35	Falco	1917/18
4	104	Tebu, of Cufra		+ 15	Sabatini	1934
5	109	Bagdad, insane		+ 35	Mutrux-Bornoz	1937
6	200	Rwala Arabs	m	+ 48.5	Shanklin and Cummins	1937

* Series contains 12 per cent females.

** 20 males and 12 females.

A slightly smaller number of subjects (854) is available from northern Africa. In contrast to the west, center and south, it can be shown with nearly as great reliability that in Lybia and in the Tebu tribe of the oasis of Cufra that the pair-group is valid, as in Europe and Asia. If the admixture of negro blood is responsible for the development of the *tipo negro* in Libyans it seems to be of special interest that the crossing with Arabian partners leads to the conservation of the pair-group rule, contrasting with the situation met with in Jamaica and Cuba.

The facts presented are sufficient to suggest the existence of two contrasting types of dactyloglyphic symmetry in human races. One expression of symmetry, that of the pair-group rule, may be stated confidently as a near correspondence in pattern frequencies of the thumb and annular of the same hand, while the second should be cautiously described as a lack of this condition in which the thumb and annular approach the bilateral symmetry characteristic of the other digits. To establish securely this second rule of symmetry, the rule of all pairs including the thumbs and annulars, and to fix the boundaries of the two opposing conditions will require much additional material. It is to be hoped that further investigations will be carried out in the dark continent, particularly in its eastern section which remains entirely unknown from the standpoint of dactyloglyphics.

LITERATURE CITED

BONNEVIE, K. 1924. Studies on papillary patterns of human fingers. *J. Genetics*, vol. 15, pp. 1-111. [*Norway.*]

BUGGE, J. N. 1932. Til Papillaermønstrenes Statistik. *Meddelelser om Danmarks Antropologi*, vol. 3, pp. 387-392. [*Denmark.*]

CUMMINS, H. 1930. Dermatoglyphics in Negroes of West Africa. *Am. J. Phys. Anthrop.*, vol. 14, pp. 9-21.

———. Dermatoglyphics in blacks, browns and whites of Cuba. Manuscript.

DANKMEIJER, J. 1934. De Beteekenis van Vingerafdrukken voor het anthropologisch Onderzoek. Dissertation, Bosch & Zoon, pp. 98. [Holland, Efé pygmies.]

DAVENPORT, C. B., and M. STEGGERDA. 1929. Race crossing in Jamaica. *Carneg. Inst. Wash.*, Pub. no. 395. [Blacks, browns.]

DUFFAUX, M. 1931. Contribution à la statistique dactyloscopique chez les Chinois et chez les prostituées chinoises. *Bibl. de la rev. internat. de Criminalistique*, pp. 6.

FALCO, G. 1917-18. Sulle figure papillari dei popastrelli delle dita nei Libici. *Riv. di Anthropol.*, vol. 22, pp. 60.

FLEISCHHACKER, H. 1934. Untersuchungen über das Hautleistensystem der

Hottentotten-Palma. *Anthrop. Anz.*, vol. 11, pp. 111-148.

GALTON, F. 1892. Finger Prints. *London*, Macmillan and Co., pp. 216.

MØLLER, N. BLIXENKRONE. 1935. Undersøgelser over Finger-aftrykket som konstitutionelt Kendetegn ved Sindssdomme. *Hospitalstidende*, pp. 1085-1111. [The dactylodiagram in schizophrenia and other psychoses.]

MUTRUX-BORNOZ, H. 1937. Les troublantes révélations de l'empreinte digitale et palmaire. *Lausanne*, F. Roth & Cie., pp. 285. [Pygmies, pygmoids and negrillos; Bagdad.]

POLL, H. 1934-a. Dactylographischer Index. *Naturwiss., Jahrg. 22*, p. 12

———. 1934-b. Rasse, Krankheit und Dactylogramm. *C. R. Congrès internat. Sci. anthrop. et ethnol., London*, p. 113.

———. 1935. Dactylographische Geschlechtsunterschiede der Schizophrenen. *Monats. f. Psychiatry u. Neurol.*, vol. 91, pp. 65-71.

SABATINI, A. 1934. Le figure tattili delle dita della mano e delle regioni plantari nei Tebu di Cufra. *Giorn. di Med. mil.*, Fasc. VI

SEMENOWSKY, P. S. 1927. Die Verteilung der Haupttypen der Finger-Epidermis-Muster beim Menschen. *Russ. Anthrop. Zeitschr.*, vol. 16. [Russians.]

SHANKLIN, W. M., and H. CUMMINS. 1937. Dermatoglyphics in Rwala Arabs. HUMAN BIOLOGY, vol. 9, pp. 357-365.

VAN DER WAERDEN, B. L. 1936. Messung von Wahrscheinlichkeiten, insbesondere Mortalität von Krankheiten, Operationen usw. *Sitz.-ber. d. Sächs. Acad. d. Wiss.*, vol. 17.

WENINGER, M. 1936. Untersuchungen über das Hautleistensystem der Buschmänner. Ein Beitrag zvr Stellung der Buschmannrasse. *Mitt. d. Anthrop. Ges. in Wien*, vol. 66, pp. 30-46.

BIO-PHYSICAL FACTORS IN RELATION TO FUNCTIONAL IMBALANCES*

BY TRIGANT BURROW, M.D., PH.D.

Scientific Director, The Lifwynn Foundation, New York City

I

WHETHER the behavior to be investigated is individual or social, fundamentally the study of behavior is the study of protoplasm, and the method of studying it is invariably experimental. Evidence derived from the observation of reactions occurring within social groups gives indication that the organism of man does not now function unobstructedly from the basis of its protoplasmic motivation as a whole.[1] In his experimental investigations of neural growth in *Amblystoma*, Coghill has emphasized the function of the organism's total action-pattern in contrast to its reflex, partial patterns of action.[2] In Goldstein's discrimination between "ground" and "figure"—terms he borrowed from the Gestalt psychologists—this investigator also emphasizes in the field of experimental neurology the

---

* Paper read at the Ninety-third Annual Meeting of the American Psychiatric Association, Pittsburgh, May 12, 1937.

[1] Burrow, Trigant. The Biology of Human Conflict. An Anatomy of Behavior, Individual and Social. *New York*, The Macmillan Company, 1937.

[2] Coghill, G. E. Anatomy and the Problem of Behavior. *London*, Cambridge University Press, 1929.

———. The structural basis of the integration of behavior. *Proceedings of the National Academy of Sciences*, 1930. Vol. 16, pp. 637-643.

———. Individuation versus integration in the development of behavior. *The Journal of General Psychology*, 1930, Vol. 3, pp. 431-435.

———. The neuro-embryologic study of behavior; principles, perspective and aim. *Science*, 1933, Vol. 78, pp. 131-138.

———. The biologic basis of conflict in behavior. *The Psychoanalytic Review*, 1933, Vol. 20, pp. 1-4.

central significance of the organism's total behavior in contrast to its secondary, more specialized reactions.[3]

In our experimental work with groups and with reactions occurring within them inter-individually, my associates and I have likewise been led—and quite independently—to discriminate between the organism's integral behavior-reactions and what I have called its partitive behavior-reactions.[4] The integral behavior-reactions are those which relate to the organism's primary integration both as an individual and as a phylum. These are man's *neuro-central* or organismic patterns of motivation. The partitive behavior-reactions, on the other hand, are secondarily acquired by each individual as gradually he builds up the system of verbal images that constitutes his symbolic or mental life. In contrast to the organismic, neuro-central patterns of reaction, these partitive responses belong to man's *neuro-social* or to his symbol-forming patterns of motivation.[5] Our experiments within groups give indi-

---

[3] Goldstein, Kurt. Der Aufbau des Organismus. Einführung in die Biologie unter besonderer Berücksichtigung der Erfahrungen am kranken Menschen. *The Hague*, Martinus Nijhoff, 1934.

———. Das Symptom, seine Entstehung und Bedeutung für unsere Auffassung vom Bau and von der Funktion des Nervensystems. *Archiv für Psychiatrie*, 1926, Band 76, pp. 84-103.

———. Die ganzheitliche Betrachtung in der Medizin. Einheitsbestrebungen in der Medizin. *Dresden und Leipzig*, Theodor Steinkopff, 1933, pp. 143-158.

———. The problem of the meaning of words based upon observation of aphasic patients. *The Journal of Psychology*, 1936, Vol. 2, pp. 301-316.

———. The modifications of behavior consequent to cerebral lesions. *Psychiatric Quarterly*, 1936, Vol. 10, pp. 586-610.

[4] Burrow, Trigant. The Structure of Insanity. A Study in Phylopathology. Psyche Miniature Series, *London*, Kegan Paul, Trench, Trubner & Co., Ltd. 1932.

———. The morphology of insanity as a racial process. A study of attention in relation to adaptive disorders. *The British Journal of Medical Psychology*, 1933, Vol. 12, pp. 296-312.

[5] In a paper written recently for a sociological journal (see Note 6) I used the term "neuro-social" to describe the organism's basic patterns of reaction in contrast to the more superficial patterns to which I referred as "politico-social". In the present article which is addressed to physicians and psychologists I have reverted to a more biological usage. The term "neuro-social", therefore, which in my earlier paper defined the organism's more basic behavior-reactions, is used in the present essay to describe man's superficial behavior-patterns in contrast to what I speak of here as the organism's "neuro-central" patterns of reaction.

cation that man's behavior-aberrations, specifically the aberrations we call mental and nervous disorders—not to mention man's more widespread social anomalies of behavior—are closely bound up with certain deviations in protoplasmic function attendant upon his acquirement of this reflex system of symbols or of language. Investigation gives indication that man's primary total function and his more restricted partitive or socio-symbolic function have become seriously entangled and confused, and that the overlapping of the two systems now causes conflict within the sphere of the organism's behavior both as an individual and as a phylum.[6]

The motivation of man as a phylum and his motivation as an individual normally arise from the common and integral basis that primarily coordinates these two aspects of man's behavior—the individual and the phyletic—into a unitary organismic whole. But instead of reacting socially from this integral basis common to the individual and to the phylum, the separately acquired part-function of the individual, represented in the neuro-social function of the symbol or of language, has assumed an arbitrary, partitive independence toward the total organism of man, and now even functions antagonistically in relation to the organism in its basic and integral motivation as a species.

II

It should be recalled that in the study of an organism's total reactions in contrast to its partial reactions investigators have included in their observation not only those partial patterns which represent pathological deviation from the total pattern but also those partial, reflex patterns that are normal. So, too, in dealing with socio-symbolic deviations occurring within the phylum man, the investigations of my associates and myself have included not only deviations that are obviously pathological but also those partitive, reflex digressions from the total pattern that characterize normal behavior. Where investigations of the group

---

[6] Burrow Trigant. The law of the organism. A neuro-social approach to the problems of human behavior. *The American Journal of Sociology*, 1937, Vol. 42, pp. 814-824.

———. The organismic factor in disorders of behavior. *Journal of Psychology*, 1937, Vol. 4, pp. 333-341.

———. The organism as a whole and its phyloanalytic implications. An organismic approach to disorders of human behavior. *The Australasian Journal of Psychology and Philosophy*, 1937, Vol. 15, pp. 259-278.

are made *from within the group*—where they are made not only from the standpoint of the neuro-social onlooker, but also from the inclusive basis of man's common neuro-central or organismic pattern of motivation—these investigations readily disclose the presence of an alien and unassimilable element, of an ulterior and contradictory factor or trend that causes division and discord within the organism's behavior as a whole.

Viewed from the integral background of motivation inherent in the group or phylum this ulterior element with its attendant conflict is as invariably present in the so-called normal personality as in the personality of the neurotic. Investigation shows that this conflict intercepts the spontaneous behavior of normal individuals in their customary interchange as definitely and as reflexly ("unconsciously") as it intercepts the spontaneous behavior of the psycho-neurotic. It would appear therefore that, in assuming his normal, neuro-social patterns of motivation as basic, man has reckoned without adequate allowance for the primary principle of motivation that resides in the total pattern of action pertaining to the phylum as a whole. In short, it would appear that in reckoning with man's disorders of behavior only upon a neuro-social level man has reckoned without his host.

Freud and his followers long ago recognized that the reaction-instance subjectively, symbolically, experienced as the wish is an affect-reaction that completely dominates the behavior of the psychoneurotic personality.[7] But phylobiological or intra-group analysis, which includes the reactions of the observer along with the reactions observed, makes evident that the affect-reaction subjectively experienced as the wish is a reaction-instance that dominates the behavior of the community at large. This motivation reflected in the wish and now governing human behavior is as yet completely unrecognized by man to be a behavior-motivation that affects his reactions as a community or species. It yet remains for man to realize that the dominance of the affective reaction-instance experienced subjectively as the wish is not an individual *faux pas* but a phyletic anomaly. It is noteworthy, however, that in the psycho-neurotic as in normal individuals the phenomenon known psychically as the wish is found only in the sphere of man's neuro-social

[7] A description of the pleasure principle as presented by Freud will be found in my paper, Conscious and unconscious mentation from the psychoanalytic viewpoint. *Psychological Bulletin*, 1912, Vol. 9, pp. 154-160.

or symbolic behavior, that the capacity to employ mental or psychic images in the expression of his wishful feeling and thinking is a function alone of the symbolic segment of man's organism.

III

The physiological psychologists have long recognized that beneath certain subjectively appreciable states of the individual—beneath the emotional reaction of anger or fear, as beneath the state experienced as hunger, fatigue or grief — there are traceable definite physiological alterations internal to the organism.[8] In like manner our group studies give indication that the affect-state subjectively expressed throughout the phylum of man as the wish is appreciable in definite physiological tensions internal to the organism. Our experimentation with individuals and with groups further shows that these internal alterations occurring in the symbolic segment and producing the affect-reactions experienced subjectively as the wish may be sharply discriminated from the internal tensional alterations which regulate the organism in its primary behavior as a whole. These two patterns are discriminable from one another because of a conflict between the integral physiological designs that takes place at their point of juncture. This point of juncture and its attendant conflict may be detected especially in the zone of the eyes because of the dual relation of this zone or segment to the total and the partitive reaction-systems. According to the dominance of the configural design the function of the eye-movements is very different in the two patterns. That is, the two integrative patterns or ambits present a different configuration or design according as the movements of the eyes and their attachments occur in relation to the pattern of behavior of the organism as a whole, or in relation to the pattern that motivates the organism in its partitive (neuro-social) or symbolic adaptation.[9]

---

[8] Cannon, W. B. Bodily Changes in Pain, Hunger, Fear and Rage. (2nd edition) *New York*, Appleton, 1929.

———. The physiological basis of thirst. *Proceedings of the Royal Society of London*, 1918, Vol. 90B, pp. 283-301.

James, W., and Lange, G. C. The Emotions. *Baltimore, Md.*, Williams and Wilkins, 1922.

Blatz, W. E. The cardiac, respiratory and electrical phenomena involved in the emotion of fear. *Journal of Experimental Psychology*, 1925, Vol. 8, pp. 109-132.

[9] Experiments undertaken in 1937 at the summer research station of The Lifwynn Foundation at Merrill, New York, give indication of a new and significant field of observation in relation to human behavior. The instrument used con-

It should be noted that man's neuro-social or symbolic pattern of motivation represents a biological innovation that is acquired within the life experience of the individual. Only in the gradual process of learning does the organism acquire the complex of neuro-social reactions that represents man's reflex system of symbols or verbal images with their attendant affects. As this partial pattern marks an innovation within the life of man that entails a conflict with the more ancient patterns of his primary organismic life, it stands in sharp contrast to these patterns. Something takes place within the organism individually and as a community that is definitely extraneous to its primary organismic life. But while man's neuro-social or symbolic adaptation is a functional variation that is repeated within the life of each individual, this functional innovation has taken place throughout the species of man as a whole. Man's neuro-social processes are, therefore, functional at the same time that they are morphological, they are individual at the same time that they are generic. It is due to this circumstance that the neuro-social or symbolic modification in man may be localized and rendered discriminable from the physiological modifications which underlie man's more ancient, instinctive, total patterns of response.

IV

If man's behavior-disorders represent a neuro-social deflection from the organism's primary internal patterns of reaction, if man's anomalies of behavior are really protoplasmic and physiological, only a form of internal orthopedics will be competent to remedy these bio-physical maladjustments internal to the organism. Our task, then, is that of isolating the "partial action pattern", to use Coghill's term, and of determining its relation to the organism's "total pattern of action". But it is more than this. It is to recognize that the partitive pattern of modification concomitant to the organism's symbolic behavior has overtly encroached upon

---

sisted of an apparatus specially constructed at the Harvard Psychological Laboratory for the laboratory of The Lifwynn Foundation. This apparatus, consisting of a multiple kymograph, is a modification of the device originally constructed at Harvard by Volkmann and Gerbrands. Even the tentative experiments thus far made appear to indicate a significant difference in the character of the respiratory curves obtained during a subject's symbolic activity with its accompanying visual convergence and the tracings obtained under conditions that excluded mental imagery with concomitant visual accommodation. A detailed description of these preliminary experiments will appear in a paper by the author now in preparation.

the organism's primary behavior as a whole, and that this encroachment has, in the terms of Goldstein, reversed the relationship of "figure and ground". It is to recognize that the organism's partitive, or neuro-social behavior—the organism's partial action-pattern or figure—in becoming over-emphasized, has dominated and, in effect, inverted its relation to the primary organismic behavior of man both as an individual and as a phylum. From this altered phylobiological frame of reference it is entirely consistent to say that this reversal of figure and ground within the species has entailed a community-wide deflection within the primary, organismic behavior of man throughout. In the last analysis, therefore, it becomes our task to re-integrate these dominant symbolic part-reactions into the organism's total pattern of motivation and, in so doing, to subordinate them to the primacy of the organism's behavior as a whole.

And this brings us to the matter of actual technique. The technique employed in discriminating the wish-motivated or neuro-social pattern of behavior from the neuro-centrally motivated pattern of behavior requires that the student, whether normal or neurotic, whether physician or patient, centre his interest upon the physiological segment that is most acutely involved in this neuro-social deviation. Accustomed as we now are to the constant employment of symbolic thinking in our relation to each other and to the external world, it is difficult for us to realize in terms of appreciable physiological sensation the primary function of the eyes in their total, organismic relations. Nevertheless in man, as in other animals, the eyes were originally employed as part of a primary bionomic system which related the organism as a whole to the total environment, prompting the organism's interoceptive choice or rejection of the objects of the outer world according as they conserved or failed to conserve the life of the organism as a whole. We have, of course, a theoretical knowledge of this primary function of the visual segment as it existed in man prior to his acquirement of the reflex integrations that are coincident with the development of language. But with our present overwhelming use of symbols, complicated as they now are with the affects or wishes that have become amalgamated with them, man's tendency is to forget the prior function of the eyes and thus to disregard their integral relation to the organism as a unitary whole.

Upon investigation, then, it is found that the eyes occupy a position which stands functionally midway between the reaction-constellation that constitutes the physiological pattern of the neuro-social segment on the

one hand and the organism's total proprioceptive or neuro-central pattern of reaction on the other. In the pattern-complex that makes up the neuro-social, symbolic system of reactions, the organ of vision, as we know, occupies physiologically an important position. In the ocular tensions associated with verbal mentation or symbolic perception the eye serves, of course, the function of recognizing an object or process to which the organism's exteroceptive attention has been drawn. Several investigators have shown that very fine eye-movements accompany the function of symbolic perception and that these movements are a necessary concomitant to the process of thinking and imagination.[10]

Investigation of the relation between the primary and the partial patterns of reaction further makes evident that in the larger pattern-complex that comprises the organism's primary total action, the visual organ occupies a no less central and important rôle. The eye with its muscular system of tensions and strains is of central significance in the organism's kinesthetic, stereognostic and general neuro-central function. In maintaining the organism's equilibrium, in coordinating its relation to outer space and time, and in the adjustment of its general muscular tone and balance in respect to the objects of the outer environment, the eye and its appendages play an exceedingly important rôle. Because of this central position which the eye occupies functionally between the organism's neuro-social or partial action-pattern and its neuro-central or total pattern of response, the organ of vision constitutes physiologically an organic integral that is common to both these systems. One would expect, therefore, that this organ common to the two systems—the neuro-social and the neuro-central — would be especially disposed to register whatever conflict or overlapping of function has been induced through a disparity of tensions between the two pattern-complexes—between the dual functions embodied in the organism's neuro-social and its neuro-central systems. As a matter of fact one finds through actual internal observation that the organ of vision and its adjacent structures afford a significant clue in the effort to give sharper outline to the sensation of overlapping and conflict existing between these two reaction-patterns. In the contradictory and quite irreconcilable sensations ob-

---

[10] Jacobson, Edmund. Electrophysiology of mental activities. *American Journal of Psychology*, 1932, Vol. 44, pp. 677-694.

———. Electrical measurements of neuromuscular states during mental activities; Evidence of contraction of specific muscles during imagination. *American Journal of Physiology*, 1930, Vol. 95, pp. 703-712.

servable at this point of juxtaposition between the two physiological patterns one finds a valuable entering wedge to the internal physiological conflict between them. One finds that this point of coalescence between the two systems provides him with a definite means for observing the organism's behavior in respect to two differential systems of response that have become too closely interrelated.[11] It is found that the tensions of the eye and its associated structures in orienting the organism in respect to the environment symbolically or neuro-socially possess a wholly different character from the tensions of the eye and its associated structures when responding as an element within a total neuro-central system of kinesthetic balance and coordination.

But it should be emphasized that our investigations of internal strains and tensions have not concerned themselves primarily with these internal manifestations as they become perceptible merely in this or that particular neuromuscular segment or body-part, or as they occur in this or that particular individual. They are concerned with perceptible tensions as they are related to the behavior of man's organism as a whole. The sensations and reactions which are bound up with man's symbol- or word-conditioned reflexes are not only inadequate to represent the organism in its total behavior-response, but they tend to occupy a position physiologically that is in direct opposition to the organism's total behavior. Through the gradual intervention of word-conditioned reflexes man is now subject to disordered physiological functions which, while widely operative socially, have not as yet been phyletically investigated, and in consequence their generic significance has been quite overlooked.

V

The method to which I refer has not been derived from theoretical or conceptual principles. Beginning in 1920 I have worked intensively with groups composed both of normal and neurotic subjects, and this work has included my own processes along with the processes of the patients, students and associates who have worked in cooperation with

---

[11] Pavlov, Ivan P. Lectures on Conditioned Reflexes. Twenty-five Years of Objective Study of the Higher Nervous Activity (Behavior) of Animals. With an introduction by Professor W. B. Cannon. *New York*, International Publications, 1928.

me.[12] My effort from the first was directed toward isolating, if possible, the common element responsible for the organism's domination by affective or wishful impulses—man's partial pattern of behavior—as they exist equally in the "normal" community and in the neurotic patient. For experimentation showed that, in their neuro-social adaptation, normal as well as neurotic individuals are completely subordinated at all times to the partitive pattern of response embodied in the linkage between affect and symbol. They are subordinated completely to the reflex alliance between the psychic signal (the word) and the psychic response (the affect) that now exists socially among us. What is more, all our symbolic or neuro-social efforts to separate the affect from the symbol proved utterly ineffectual. It is true that affect-images are often subject to revision through the ordinary psychiatric channels of understanding, counsel and reinterpretation, but when it comes to a question of divorcing *in toto* the sphere of the wish or the affect from the sphere of the symbol, our current psychic methods of therapy prove unavailing. While our group experiments made evident that the wide and invariable disparity between the individual's words and the wish that lay back of them is a phenomenon specific to the inter-individual, neuro-social or symbolic pattern of human interchange, the important factor in these early experiments was the disclosure that no amount of neuro-social insight was of the least avail in the effort to bridge and resolve this reaction-conflict. It was because of the repeated frustration of my efforts to deal with neurotic and normal conflicts as reflected in the organism's neuro-social patterns of reaction that I was led to adopt an experimental procedure which would reduce our inquiries to more basic bio-physical principles.

---

[12] Burrow, Trigant. Social images versus reality. *The Journal of Abnormal Psychology and Social Psychology*, 1924, Vol. 19, pp. 230-235.

———. Our mass neurosis. *The Psychological Bulletin*, 1926, Vol. 23, pp. 306-312.

———. Insanity a social problem. *The American Journal of Sociology*, 1926, Vol. 32, pp. 80-87.

———. So-called 'normal' social relationships expressed in the individual and the group, and their bearing on the problems of neurotic disharmonies. *The American Journal of Psychiatry*, 1930, Vol. 10, pp. 101-116.

———. Physiological behavior-reactions in the individual and the community. *Psyche* (*London*), 1930, Vol. 11, pp. 67-81.

VI

The procedure I am proposing in my effort to meet the problem of behavior-disorders is a direct and eminently practical one. It means the application of a physiological, medical procedure to the aberrations or disorders expressed in behavior deviations. It means that the physician occupied with behavior-disorders will adopt a procedure toward his patient that is as concrete medically, biologically, as is the procedure of the physician who deals with any other disorder falling within the domain of medical practice. Instead of attempting to cope with a patient's psychic phenomena or with the epiphenomena expressive of this factor of the affect or the wish—instead of being occupied with the endless thoughts, hopes, ideas and disappointments, with the phobias, the resistances, the transferences, the dependencies, and the infinite variety of a patient's psycho-sexual maladjustments, actual or repressed —the student of behavior will apply himself to the physiological tensions and alterations that constitute the organic substrate of these psychic or epiphenomenal processes. Abrogating the patient's dreams and phantasies, his compulsions, obsessions and intricate rationalizations, together with their psychiatric systematization in the complex anomalies of behavior we know as schizophrenia, hysteria, compulsion neurosis, the alternations of manic-depressive psychosis etc., etc., the physician will direct his own and the patient's neuromuscular patterns of reaction, now involving conflicting part-tensions antagonistic to their common, total phylum, into physiological tensions which are in harmony with and fully assimilable by the organism as a whole.[13]

---

[13] At the meeting a year ago of the American Psychiatric Association it was reported that three psychoanalysts had ministered to the "unconscious" of a certain well-to-do lady for nine consecutive years, the procedure having been conducted on a basis of successive relays that occupied some three years for each physician. The project that connected the Atlantic and Pacific Oceans by means of the Panama Canal occupied but ten years. And even the vast reconstructive plan of the Russias required only little more than half this duration. Fancy, then, three psychiatric experts picking the brains of one woman for an hour daily over a period of nine years! If this isn't a clear case of *folie à deux* the literature does not afford one. And yet, believe it or not, the difficulty of which the patient in question complained was "a lack of adjustment to reality"! Does any one wonder that according to the clinical report the patient's sense of unreality was not less marked at the end of her novena than when she set forth? But if we think these eminent physicians amusing, if we think their behavior bizarre, we have only to consider the degree in which this type of tomfoolery characterizes the neuro-social

The effort to re-integrate partitive patterns of behavior that have become dominant in respect to the organism's total pattern of motivation is not a light undertaking. In theory the procedure is simple enough, but in actual practice one's habitual subordination to neuro-social or symbolic reflexes constantly tends to defeat the student's effort. As I have said, however, the recourse which has been of significance to me and to others associated with me has been to direct our observation upon sensations occurring in the region of the eyes. With continued practice one very soon acquires a sense of the differentiation between those tensions associated with verbal or mental images and those tensions which pertain to the organism as a whole. As the neuro-social system with its artificially linked affect and symbol is bound up with man's inter-individual or symbolic wish-impulse and with the endless mental symptoms, isolated and systematized, that go along with it, the reassimilation of the neuro-social pattern into the organism's primary, neuro-central pattern or configuration tends gradually to reestablish in the individual and in the group the behavior that is primary and inherent in the organism as a whole.

As man's partitive, neuro-social patterns of behavior are as characteristic of normal processes with their social give-and-take as of the behavior of neurotic patients with their shut-in habits of rumination, it is incumbent upon physicians and educators as elements within a normal community to apply this same physiological method of adjustment in reference to the external, neuro-social forms of adaptation characteristic of normal processes. Instead of occupying ourselves with neuro-social agreements or disagreements as these behavior-reactions constitute the torturing dilemmas and conflicts of the neurotic patient and as they occur in the inter-individual and international competitiveness characteristic of social groups, we will attempt to recognize in these behavior-processes the dominance of partial patterns of reaction that are antagonistic to man's total pattern of behavior as a phylum. From this bio-physically altered frame of reference we shall seek to remedy inadequacies in individual and social adjustment through a technique that permits the restoration of the organism's total pattern of behavior in its primary sovereignty over secondary, partitive patterns.

---

community generally. For such bizarre expressions are only part of the normal "unconscious", or the system of partitive reflexes which, as a species, we have arbitrarily substituted for the organism's basic behavior as a whole.

It is therefore suggested that this physiological method of differentiating between the constellations of phantasy and actuality, between the wish and the direct environmental stimulus to total action, be adopted as a means of adjusting disorders of behavior generally. It is suggested that rather than adhere to the psychological method of analyzing each separate wish as it is presented symbolically in each separate individual, students of behavior employ a physiological technique of adjustment such as will reach the processes immediately responsible for disorders of behavior as they occur in the individual and in the community.

TUBERCULOSIS AND CIVILIZATION[1] PART I. BASIC FACTS AND FIGURES IN THE EPIDEMIOLOGY OF TUBERCULOSIS

BY GEORG WOLFF[2]

> "Kein organisches Wesen ist ganz der Idee, die zugrunde liegt, entsprechend; hinter jedem steckt die höhere Idee. Das ist mein Gott, das ist der Gott, den wir alle suchen und zu erschauen hoffen, aber wir können ihn nur ahnen, nicht schauen."
>
> (Goethes Unterhaltungen mit dem Kanzler Friedrich v. Müller. Hersg. von C. A. H. Burkhardt, Stuttgart, 3 Aufl., S. 177.)

I. INTRODUCTION

IT WAS with the above quoted aphorism of Goethe's that the psychiatrist Kurt Hildebrandt concluded a thoughtful chapter on the "Idea of the Norm" contained in his very valuable treatise *Norm und Entartung des Menschen,* founded on Plato's conceptions. The first edition of this book, written between 1911 and 1916, was published shortly after the war and had as a sequel a volume entitled *Norm und Verfall des Staates.* Naturally the author referred in this book to the conception of race which in those days had as little to do with political anthropology as had Galton's Eugenics.

---

[1] From the Department of Biology of the School of Hygiene and Public Health of the Johns Hopkins University. The substance of this paper formed the first of a series of three special lectures at the London School of Hygiene and Tropical Medicine, delivered in October, 1937.

The author is deeply indebted to Professor Major Greenwood, F. R. S. (London) for the translation of these lectures, and is thankful to Professor Raymond Pearl (Johns Hopkins University, Baltimore) for the opportunity to continue the tuberculosis work.

[2] Fellow in Biology, 1937-38, under a grant from the Emergency Committee in Aid of Displaced Foreign Physicians.

We may distinguish between the sound and unsound, but the fundamental question in any problem, as Hildebrandt asked himself, is what we really mean by normal. He finds support in the results of the Mendelian laws and defines as degenerate [*entartet*] or abnormal, pathological mutations which are correlated with a functional organic disease or inferiority.

It is true that the determination of the normal in biology and pathology and above all biometry, regarded as a natural science, is the first subject in all quantitative researches. Hildebrandt from the high peak of philosophy, looks down upon statistics as a formal method with a certain scepticism: "To a statistical age nothing seems easier than the determination of the norm, one calculates the average and this is the derived norm. How are we to interpret the results of such an objective mathematical proceeding? Genius and Idiot are equally removed from the average, both therefore are abnormal. (To whom this conclusion is more agreeable than to the average man). The true naturalist will always realize the ambiguity of statistics and only employ statistics with caution and as an auxiliary". (*loc. cit.*, p. 65).

One might add that the true statistician, that is to say, one trained in the foundations of scientific thought, like every other true man of science, is equally conscious that statistics is only a method, an instrument to be applied to the data of natural science, social science, mental science, and many other fields of knowledge. On that account nothing is more profitable to the statistician than to have a sound knowledge of the speciality which provides him with material for an analysis. If he is himself a specialist in this field so much the better, for then he will know what is behind the figures. This, of course, applies to other methods, such as microbiological investigations in medicine. Of course, there are men of genius who are exceptions to the rule; the bacteriologist, Louis Pasteur and the statistician, Karl Pearson, were not trained biologists. But the beauty of a method should never disguise the problem as sometimes happens; yet a knowledge of method is naturally an indispensable preliminary for the solution of problems.

In this matter of norms we should be still nearer agreement with the sceptical philosopher, had he shown us some other plan of determining the borderline of the normal. This, Hildebrandt does not do but a little later he does give, following Plato's train of thought, a very beautiful and almost intuitive definition of the norm: "The norm or normal is an

idea, a picture, which can be seen even if it is not presented to the bodily senses."

We shall not dwell on the significance of the norm idea as a picture (as distinct from the abstract conception of Immanuel Kant) nor discuss its power in the ordering of biological variability of the individual. But it brings us nearer in our subject, namely, the relation between disease and civilization; for the degeneration of civilised man or the pathology and biology of the race is rather a picture that can be seen than something capable of an exact definition. In the consideration of an investigation on tuberculosis and cancer, subjects of greatest interest from all these points of view, we shall attempt to illustrate their relations.

Relations of frequency can only be determined by statistical methods; a normal frequency of tuberculosis or cancer in different races or social strata cannot be said to exist; at the most we have a probability based upon those mass observations the adequate intellectual expression of which is statistical. We do not hold that in this statistical age all forms of biology or even physiology, art and aesthetics should be judged by statistical standards. But the goal of a natural science will constantly be a quantitative determination of its conformity to law as Kant in his famous introduction to *Metaphysische Anfangsgründe der Naturwissenschaft* clearly expresses: "It is my opinion that in any branch of nature study there is only just as much real science to be found as we find therein mathematics."

Only under these circumstances when objective determinations replace assertions and subjective decisions, in pathology and biology, sociology and especially racial pathology, can these subjects make any claim to be regarded as natural sciences.

2. FACTS AND FIGURES IN THE EPIDEMIOLOGY OF TUBERCULOSIS

Neither historians of medicine nor epidemiologists doubt that tuberculosis is an ancient disease of the human race. Recognizable descriptions of pulmonary tuberculosis are to be found in the writings of Greek, Roman, and Arabian physicians, although, of course, the pathological and etiological connections were but little understood. The proof of infectiousness and the nature of the infections were confirmed by Robert Koch's classical discovery and pure cultivation of the tubercle bacillus in 1882 which set a seal upon the experiments some twenty years earlier of the French clinician Jean Antoine Villemin, who in 1865 produced the disease by inoculation of tubercular material into experimental ani-

mals. Upon this great foundation the experimental study of tuberculosis has been built. We have differentiation of human and bovine tuberculosis made by experiments on guinea-pigs and rabbits, a differentiation of importance in the pathogenesis of particular localizations of tubercle as well as in certain special problems of epidemiology. Furthermore in connection with the work of Metschnikoff and Ehrlich on immunity, special applications within the field of tuberculosis immunity were made, such as, for instance, Pirquet's diagnostic method; and lastly a continuance of the work initiated by Koch and his colleagues, having for its object the specific treatment of latent or open tuberculosis by exhibition of a substance toxic to the existing organisms (tuberculin treatment). These later investigations have been supplemented by efforts, particularly those of Calmette to obtain a method of protection against tuberculosis having an analogy with Jenner's smallpox vaccination. The plan has been to employ living but avirulent tubercle bacilli (B.C.G.) and saprophytes (tuberculosis of cold-blooded species, Friedmann's organisms). Some time ago Behring attempted to eliminate cattle tuberculosis by an inoculation of dried tubercle bacillus of the human type. These attempts were unsuccessful as would be expected in a disease the course of which is as slow as that of tuberculosis in man, and thereby shows that in the majority of cases natural infection does not produce an enduring immunity. This is the sharpest contrast to such cases as that of smallpox.

What then are the factors which have produced the decline of the mortality from tuberculosis observed during, say, the last fifty years in all civilized countries? This brings us to the epidemiological consideration of tuberculosis. It is a pestilence which always claims its premature victims in the living population, that is to say, forming a mass reaction of human society to be studied by the technique of statistics and social medicine. We speak to-day of the epidemiology of tuberculosis as a special part of tuberculosis research, confining ourselves merely to the mortality statistics of different lands. These statistics extend in a majority of states for hardly more than fifty years backwards; in a few, England and Prussia, for instance, rather longer. Nevertheless these data despite all their inherent defects, errors of diagnosis, changes of classification, etc., give us valuable information and establish incontestably that mortality from tuberculosis has declined enormously in the last fifty years. It is quite true that we have no exact knowledge as to the rate of mortality from tuberculosis 200 or even 100 years ago;

one has merely scanty observations and the death registers in church books in scattered towns which indicate that then tuberculosis of the lungs, called variously *phthisis pulmonum*, wasting, *Blutsturz*, etc., was a great cause of mortality. At any rate there is no reason at all to suppose that in early times tuberculosis was rare.

Prinzing (1) writes:

> In previous centuries it (mortality from tuberculosis) was certainly heavy in Europe. Wide distribution of the disease in Italian states of the seventeenth and eighteenth centuries can be inferred from methods of prevention in different towns. In the eighteenth century we have some statistical information. Through the changes in nomenclature and the failure to grasp pulmonary tuberculosis as one disease we cannot obtain reliable figures of deaths from pulmonary tuberculosis. Various attempts have, however, been made. According to a table of Süssmilch—in the time of Frederick the Great—for every 100 deaths in Berlin in 1746, 1750, and 1757, 14.7 percent were deaths from consumption and hectic fever; as the mortality (not counting stillbirths) in these years was 37.6 per thousand, it appears that there would be 553 deaths from the two mentioned causes for every 100,000 persons.

Prinzing adds the calculations of Gottstein (2) for Breslau for 1687-91, and Peller (3) for Vienna for 1752-54; the famous calculations of Sundbärg (4) for the mortality from pulmonary tuberculosis in Sweden for the period 1751-1830 show particularly, for Stockholm, an astonishingly high mortality (Table 1).

TABLE 1

Mortality from pulmonary tuberculosis per hundred thousand population (After Sundbärg)

YEAR	SWEDEN	STOCKHOLM	YEAR	SWEDEN	STOCKHOLM
1751-1760	213	732	1791-1800	240	850
1761-1770	206	689	1801-1810	251	837
1771-1780	208	744	1811-1820	269	872
1781-1790	231	877	1821-1830	277	931

Naturally these calculations are affected by many sources of error. "The causes of death were recorded by the clergy, in the period covered the prescribed nomenclature was changed 5 times, particularly unreliable

are the figures for 1750-73, in which phthisis and deaths of the respiratory organs are combined" (Prinzing). With all these reservations the calculations, such as those of Sundbärg, give us some reason to say that mortality from tuberculosis in the middle of the eighteenth century, particularly urban mortality, was very high; the rate actually increased at the beginning of the nineteenth century and reaches its peak, as far as Stockholm is concerned, with 931 per 100,000 in the decennium 1821-30. There is then a great gap until the institution of official statistics of causes of death provided us with exact data. These still showed in the first years of publication, 1876 and 1877, values of 430 and 431, which declined at first slowly. About this time other states showed in their official reports high mortality figures; in Paris in 1876-80 they fluctuated about 400 and in London and Amsterdam about 250; in Berlin about 350; in Oslo and Copenhagen more than 300, and in Budapest still at this time, more than 800 deaths attributed to pulmonary tuberculosis (5).

To-day these figures seem exorbitantly high although they actually relate to only fifty or sixty years ago. Nowadays in many countries the yearly averages found in large cities show mortality from tuberculosis of all sorts, well under 100 per 100,000. The *facts* are known although their *causes* are still disputed. In the summary in Table 2 we give a few indications taken from the official material for the most important countries where official mortality figures have been compiled from at least the beginning of the century.

According to the data of Table 2 the decline of tuberculosis has been greatest during the last half-century in Denmark, Prussia, Belgium, England and Scotland, much less in Ireland and Finland, the statistics of which only go back as far as 1876-1880. (Figures for Austria are hardly comparable, for the republic of the present day has in area and population but little in common with the ancient monarchy). In the five first named countries the figure for tuberculosis mortality is at its lowest; in the first seven European countries mentioned in Table 2 the rate of mortality is now below 100 per 100,000 living.

In most other countries the mortality figures do not extend back further than the beginning of the present century. We note that the mortality from tuberculosis in the quinquennium 1926-30 in the registration area of the United States of America was nearly as low (79 per 100,000) as in little Denmark (76 per 100,000) and actually lower than in any other European state. Still lower was the mortality figure for Australia (50 per 100,000) and New Zealand (41 per 100,000). These

TABLE 2

Mortality from tuberculosis per 100,000 population, in the periods 1876-80, 1901-05, 1926-30 and in the year 1933

COUNTRIES IN ORDER OF MORTALITY IN 1926-30	1876-1880	1901-1905	1926-1930	RELATIVE FIGURE 1926-30 1876-80=100	RELATIVE FIGURE 1926-30 1901-05=100	1933
1	2	3	4	5	6	7
1. Denmark[3]	313	193	76	24	39	58
2. Netherlands	...	187	87	..	47	60
3. German Empire	...	207	89	..	43	73
4. Prussia	317	191	91	29	48	76
5. Belgium	323	?	95	29	..	79
6. England and Wales	289	174	94	33	54	82
7. Scotland	336	216	95	28	44	82
8. Italy	...	167	127	..	76	99
9. Sweden[4]	...	...	131	..	..	115[10]
10. Ireland[5]	266	276	138	52	50	117
11. Switzerland	...	265	139	..	52	106
12. Spain	...	199	140	..	70	117
13. Norway	...	256	155	..	61	121
14. Austria	377	341	158	42	46	130[10]
15. France[6]	...	221[9]	166	..	75	140[10]
16. Hungary	...	396	225	..	57	170
17. Finland[7]	367	291	241	66	83	200
18. New Zealand	...	93	41	..	44	41
19. Australia	...	89	50	..	56	44
20. U. S. A.[8]	...	193	79	..	41	60
21. Japan	...	183	191	..	104	188

[3] Down to 1914 only urban areas, since 1920 for the whole country.

[4] Down to 1910 only for a few towns reported on pulmonary tuberculosis. Since then all forms of tuberculosis for the whole country. The earlier figures are accordingly not comparable with the later ones.

[5] Since 1919 only for the Irish Free State.

[6] Towns with more than 5000 inhabitants.

[7] Only pulmonary tuberculosis; since 1926-30, all forms of tuberculosis.

[8] Registration States.

[9] 1906-10.

[10] 1932.

states indeed have had for years hygienically the most favorable conditions as indicated by mortality, expectation of life, and infant mortality. Mortality from tuberculosis and infant mortality are perhaps the best indices of hygienic progress. Compared with this a high mortality from tuberculosis (191), not to speak of high infant mortality, is found in that young but greatly rising industrial state, Japan. This rate of tuberculosis is only surpassed in Europe by Hungary (225) and Finland (241). It is noteworthy that in Japan mortality from tuberculosis has been rising since the turn of the century, making Japan an exceptional case in the field of epidemiological studies in tuberculosis.

The last column of Table 2, for the sake of completeness, contains the most recent figures, namely for the calendar year 1933 (in Sweden, Austria, and France for 1932). There is not much change in the order, although the decline in mortality from tuberculosis found in Japan is evident; again the Australian states show by far the lowest figures. They are followed at some distance by Denmark, Holland and the United States of America. In Europe, Finland and Hungary, and among the rest, Japan, show again the highest rates of mortality.

That there has been a great decline in mortality from tuberculosis is, therefore, incontestable. If we consider the quinquennium 1926-30 (column 5), we may say that within the fifty years, that is to say from 1876-80 to 1926-30, in most states with sufficient data there has been a decline of from 25 percent to 33⅓ percent of the original height. Among others it is probable that the decline has hardly been smaller; for example, the United States, Australia and the Netherlands. Nevertheless, we must still regard tuberculosis, even today in spite of our success, as a most formidable cause of death. There are two reasons for this; one is that it is a cause of mortality which snatches away a human being even in the prime of life, the other is that under particular conditions it may take on an epidemic form and claim over-many victims. Some figures will enable us to orient ourselves here (Table 3).

In Berlin, 1928-30, two-thirds of the deaths from tuberculosis were of persons at ages between 15-50, as compared with one-fifth of the deaths at all ages from malignant tumors. Persons over 60 contributed only 13.3 percent of the deaths from tuberculosis but contributed more than half the total deaths from cancer. These two causes of death in their distribution over age are almost antagonistic; tuberculosis attacks those in the middle and full-working time of life, cancer on the other hand the later years. So, from the point of view of racial biology as well as

TABLE 3

Age distribution of the deaths from tuberculosis and cancer in Greater Berlin, 1928-30

AGE IN YEARS	TUBERCULOSIS			CANCER AND OTHER MALIGNANT TUMORS		
	Absolute	Percent		Absolute	Percent	
0-1	190	1.5		6	0.03	
1-15	798	6.2		104	0.5	
15-30	3897	30.2		339	1.6	
30-40	2591	20.1	66.3	1008	4.8	19.8
40-50	2065	16.0		2820	13.4	
50-60	1648	12.7		5175	24.6	
60-70	1173	9.1		6405	30.4	
70 and over	545	4.2		5186	24.7	
Total	12907	100.0		21043	100.0	

political economy tuberculosis is the more serious evil, notwithstanding that as a result of the ageing of the populations of civilized states the actual numbers of deaths from cancer are greater than those from tuberculosis. Relatively, cancer is a constant source of mortality affecting ageing people. There is even here slight indication of decline. Tuberculosis is an epidemiological product of living organisms. It is, therefore, sensitive to external factors, and given a lowered standard of living, may greatly increase. That tuberculosis, declining over the last fifty years, can flare up is shown by the experience of the world war, particularly in those lands where conditions of nutrition were difficult. Table 4 illustrates the point.

Table 4 might almost be called a romance in figures which shows the fate of nations during the World War illustrated by the epidemiology of tuberculosis. The low-water mark of tuberculosis mortality since 1880 was reached in the year 1913 with the figure of 135 deaths for 100,000 persons for England and 137 for Prussia. Calling these figures 100 one sees in the following year as a result of war quite a small increase; by 1915 it amounted in England to 13 percent; in

TABLE 4

Tuberculosis mortality in England and Wales and in Prussia immediately before, during, and after the World War

YEAR	ENGLAND AND WALES		PRUSSIA	
	Per 100,000 living	Relative figure 1913 = 100	Per 100,000 living	Relative figure 1913 = 100
1910	143	106	153	112
1911	147	109	151	110
1912	137	101	146	107
1913	135	100	137	100
1914	136	101	139	101
1915	152*	113	146	107
1916	152*	113	158	115
1917	160*	119	205	150
1918	167*	124	230	168
1919	128*	95	219	160
1920	113*	84	158	115
1921	113	84	135	99
1922	112	83	143	104
1923	106	79	153	112
1924	106	79	122	89
1925	104	77	109	80
1926/30	94	70	91	66

* Civil population only.

Prussia scarcely to 7 percent; by 1916 it was still 13 percent in England and 15 percent in Prussia. Now we come near to the catastrophe. In the two following years, 1917 and 1918, the mortality figure in England continued to rise slowly, reaching 119 and 124 percent of the figure for 1913; in Prussia there was a rapid increase of 205 and 230 deaths per 100,000, that is 150 percent and 168 percent of the original figure for 1913. In 1919 the mortality figure for Prussia, 219, which equals 160 percent of the original, remained high, while in England the recovery from the world war privations began to show itself at once. The mortality figure 128 was even slightly less than that of the best of the peace years. This tendency to decline in the mortality from tuberculosis continued in England without interruption, if slowly, as the index figures show. In Prussia the mortality figure began to fall sharply in 1920, but

with 158 deaths per 100,000 or 115 percent of the figure for 1913, it was still decidedly above the pre-war level. By 1921 the figure was slightly below this. Now we come to the 1922-23 tragic years of inflation in which mortality rates rose again to 143 and 153, 4 and 12 percent above the standard value. One notices that this increase was nothing like so great as during the war. One recognizes again how closely the mortality figure reacts to unfavourable environmental factors. In November 1923 the introduction of the *Rentenmark* brought the period of inflation to an end. Values were stabilized. Every one knew what he earned and what he could buy with it. Shortness of provisions as in the war no longer existed. For the first time the tuberculosis figure for Prussia fell decisively below the level of 1913, with a rate of 122 per 100,000 in 1924, 11 percent below the standard. This progress continued in the following years and in the quinquennium, 1926-30, the rate of tuberculosis, 91 per 100,000 was for the first time less than that for England. Actually it was 34 percent below the starting figure for 1913.

This involuntary mass experiment, freed of chance errors and made manifest by statistics, is of more epidemiological importance than endless theories of the pathology of tuberculosis; for it is shown with decisive clearness that over and above specific factors—hereditary and climatic factors—other influences are of still greater importance in the spread of the disease. One cannot really doubt that defective nourishment, in particular the lack of sufficient energy values in the national diet, together, of course, with other deteriorations of the social environment are decisive factors. Neither bacillus, nor climatic conditions, nor hereditary factors affecting the German people in the winter of 1916-17 differed from those of preceding and succeeding years.

We draw near now to the analysis of etiological factors of the epidemiology of tuberculosis. But before this there are still a few figures of the distribution by sex and age during the last decennia that we shall consider. We shall take then by way of variety the recently published excellent monograph on statistics of the Bureau of the State of Zürich (*Sterblichkeit in der Stadt Zürich* 1893-1933. *Zürich,* 1937), a very special work on comparative tuberculosis by Kruker and Senti (6). Swiss statistics are of particular value since unlike those of most countries mortality rates are corrected for locality; that is to say, in the case of persons dying away from their homes the deaths are transferred to place of habitual residence.

TABLE 5

Tuberculosis mortality in Zürich per 100 *dead of all causes of the same age and sex*

YEAR	AGES									
	Under 1	1-4	5-9	10-14	15-29	30-44	45-59	60-74	75 and over	Total
Males:										
1896-05	2.5	21.0	38.9	31.7	45.4	40.2	23.4	10.5	2.1	18.3
1906-15	2.7	18.2	26.8	27.7	41.8	34.1	18.0	7.3	1.3	16.6
1916-25	3.0	16.3	13.8	20.0	29.5	23.9	12.9	6.1	2.4	12.7
1926-33	1.7	11.0	14.4	15.5	28.1	24.4	10.4	4.0	1.8	10.1
Females:										
1896-05	2.8	24.0	39.4	51.4	58.8	37.7	18.5	8.8	2.9	18.0
1906-15	2.8	22.8	39.1	53.1	55.9	34.1	15.8	8.0	2.7	17.2
1916-25	2.5	18.7	24.6	26.3	46.8	27.0	12.1	6.3	2.3	14.1
1926-33	2.4	15.8	15.3	30.2	50.1	23.8	8.3	3.9	1.6	10.3

The proportional mortality figures of Table 5 are only insofar important as to show what a relatively large proportion of the total mortality is borne by tuberculosis in practically all age groups except the youngest and oldest. Of course this proportion must depend upon the varying weight of other causes of death and so throws no light upon the actual risks of the living. We shall see that the proportion is very small in infancy because other causes of death (debility, premature births, digestive disturbances, inflammation of the lungs, etc.) are so much more important. For a similar reason old-age tuberculosis takes a minor place in comparison with senile decay, malignant disease and cardiovascular disease.[11] In most other age classes the share of tuberculosis is large but it will be seen this share has fallen, although not regularly. Among women in Zürich still about half the total deaths between the ages of 15-30 are from tuberculosis, although at these ages women are also exposed to puerperal risks. Between the ages of 10-15 about one-third, and between the ages of 30-45 about one-quarter of the women

[11] But the actual rates of mortality of small children and the aged are by no means negligible.

who died did so from tuberculosis. Even among males the quota is high. One must however recollect that in these young and middle age classes the proportional mortality from tuberculosis does not really tell us much. The most satisfactory insight is given by a table showing the rates of mortality at ages. Table 6 is such an exhibit.

We see at once from Table 6 that tuberculosis claims its victims at all ages; indeed the rate of mortality at ages under 1 is rather high, but this

TABLE 6

Tuberculosis mortality in Zürich per 100,000 *living of the same age and sex*

PERIOD	AGES										
	Under 1	1-4	5-9	10-14	15-29	30-44	45-59	60-74	75 and over	Total Crude	Total Standardized
Males:											
1896-05	418	276	136	74	228	408	608	662	361	325	325
1906-15	282	161	70	41	148	247	385	446	199	203	203
1916-25	194	108	34	28	125	157	229	329	367	150	140
1926-33	78	41	25	20	79	121	172	203	265	108	95
Relative figure: 1896-05 = 100											
1906-15	67	58	51	55	65	61	63	67	55	62	62
1916-25	46	39	25	38	55	38	38	50	102	46	43
1926-33	19	15	18	27	35	30	28	31	73	33	29
Females:											
1896-05	376	335	133	132	250	251	284	445	440	261	258
1906-15	251	194	87	88	189	186	209	374	402	190	190
1916-25	123	104	50	32	159	132	140	249	320	140	134
1926-33	89	56	18	29	116	83	81	139	208	93	86
Relative figure: 1896-05 = 100											
1906-15	67	58	65	67	76	74	74	84	91	73	74
1916-25	33	31	38	24	64	53	49	56	73	54	52
1926-33	24	17	14	22	46	33	29	31	47	36	33

falls greatly and reaches at the school age its nadir. By the beginning of puberty, it begins to rise and remains in the following age classes rather high, especially among males. On the whole the mortality figures for females are lower than for males except at earlier ages; regularly at the ages 10-15 and 15-30 the rate of mortality for females is the higher. It may be that greater demands upon the female organism by the beginning of sex and maternal activities is the explanation. The statistical relation is borne out by the figures for all periods and is unaffected by the decline in the level of the total mortality.

In tuberculosis, unlike cancer, age standardization, when the same population is in question, has comparatively little importance. Even here there is in effect a tendency for the standardized figures to be less than the unstandardized because the mortality of tuberculosis tends to increase somewhat with age if we leave out of account the discontinuity in infancy.[12]

In the Zürich data the crude rates of mortality were, in the four periods for males, respectively 325, 203, 150 and 108 per 100,000, the standardized 325, 203, 140 and 95; unstandardized figures for females were 261, 190, 140 and 93, the standardized 258, 190, 134, and 86. Throughout, the figures for females were below those for males, but for both sexes there is an uninterrupted decline. The decline of mortality from tuberculosis is best shown by the index numbers which are put into the tables. Taking the mortality for the period 1896-1905 as 100 it will be seen that the mortality in infancy, pre-school and early school ages are not much more than one-fifth to one-seventh part of the original figure in the final period, 1926-33; and even in later school ages, 10-14, only one-quarter of the original figure. At the other ages the rate is about one-third. An exception is presented by the oldest age group, the mortality for which in males has varied very irregularly over the period, but here the absolute numbers of deaths are very small. Among women at age 75 and over, it falls to rather less than half. There is also a really exceptional case presented by the women between the ages 15-30, for in that age group (15-30) the absolute mortality figure for women is higher in all periods than for men of the same age; for instance, 116 per 100,000 in 1926-33 for women and only 79 for men. Taking all ages together the standardized mortality has fallen to less

[12] Tuberculosis of the aged is often enough not recognized in life-time or taken into consideration as a source of infection. See, for instance, Goldmann and Wolff on tuberculosis of the aged (7).

than one-third, for men to 29 percent and women 33 percent. Zürich shows the same phenomenon as West European civilized countries and the United States of America, as well as extra-European races of English stock.

In connection with the smaller improvement in the tuberculosis mortality in young women, illustrated by the Zürich statistics, attention must be directed to a particular phenomenon of most modern epidemiology of tuberculosis; namely, the actual increase in mortality from tuberculosis among young adults after the war, especially in the female sex, a matter which has been discussed in English statistics, and also in those of some Scandinavian countries.

A. Bradford Hill (8) made a particularly careful study of the course of phthisis mortality in England between 1851-60 and 1921-30 from which we may quote a few figures. Over these eight decades the standardized mortality rate from tuberculosis of the respiratory system, for both sexes, declined from 277.2 per 100,000 in 1851-60 to 76.8 in 1921-30; that is, it fell to 28 percent of the original figure.

In a finer age and sex analysis of the first six decades it appeared that the standardized mortality figure for males had fallen to a half, that of women to one-third; for both sexes in the younger age groups the improvement is appreciably greater than in the middle life and at older ages. Thus the mortality figure for young adults, males 15-25, 1901-10, was only one-third of that in 1851-60, the figure for young women only one-quarter. But over the period between 1910 and 1930 there was a change; the males showed a little retrogression, but in the females in the period 1921-30 there was a definite increase in the mortality in the age group 15-25, and at ages 25-35 a much smaller improvement than in the other groups. The years 1915-20 were left out of account owing to the disturbance of the war. A finer course is shown in Table 7 taken from Hill, using only the index numbers to show the course best. 1901-10 is put in as 100.

Table 7 shows that in the short time since the turn of the century, leaving out the war years, till the period 1927-30 in the male sex in all age classes there has been a decided decline in mortality. The improvement amounts to 40-60 percent in most age groups, but in the age group 15-25 only 24 percent, and in the age group 25-35, 39 percent. There is a slowing down. For women 15-25 there is even an increase, most distinct in the years 1921-23; here too the improvement in the age group 25-35 is much slower than at other ages.

TABLE 7

Relative figures for the mortality from pulmonary tuberculosis since 1901-10 in England and Wales

AGE CLASSES	PUTTING THE DEATH-RATES IN EACH SINGLE AGE CLASS 1901/10 = 100, WE THEN HAVE:							
	Males				Females			
	1911-14	1921-23	1924-26	1927-30	1911-14	1921-23	1924-26	1927-30
0—	74	46	44	40	76	46	41	38
5—	95	68	68	53	95	76	69	52
15—	90	90	82	76	97	111	107	103
25—	84	72	68	61	86	80	76	73
35—	86	68	64	59	84	63	55	49
45—	83	60	58	59	84	57	50	45
55—	89	61	56	53	86	57	51	46
65—	86	60	56	55	87	63	53	50
75+	90	59	50	58	93	69	59	57

When the country is divided into administrative areas, which Hill has done in an exhaustive research, in the urban areas the same phenomena are still more striking. Beside a slowing down in the decline of tuberculosis in young men, there is an increase in young women. Thus in London the increase for the latter amounts to 32, 23, and 28 percent of the rate of mortality for 1911-14, and in urban districts to 15, 11 and 5 percent, whilst in rural districts there was often no increase.[13]

The maximum, therefore, of the retrogression falls into the period 1921-23. After this improvement is shown.

A further point to note in the mortality of tuberculosis of young adults is that the mortality from pulmonary tuberculosis in the earlier decades was generally less in rural than in urban districts at all age classes except that of young adults. Among young adults, especially women, rural rates were regularly higher. This excess mortality from tuberculosis of the respiratory organs in rural districts has, in the decennium 1921-30, completely disappeared, a result which taken in connection with

[13] Hills' original paper should be consulted for the actual rates.

the increase in mortality since the turn of the century is an important point. We give for comparison only the index numbers in Table 8.

TABLE 8

Relative figures for the mortality from pulmonary tuberculosis in urban and rural areas of England and Wales

AGE CLASSES	PUTTING THE DEATH-RATES FOR THE URBAN AREAS = 100, WE THEN HAVE IN THE RURAL:					
	Males			Females		
	1891-00	1901-10	1921-30	1891-00	1901-10	1921-30
0—	69	56	48	70	64	59
5—	84	81	73	104	102	79
15—	114	112	70	129	130	89
25—	93	105	87	110	116	99
35—	63	69	65	79	83	91
45—	56	55	51	78	74	79
55—	63	57	50	88	84	81
65—	71	62	50	97	94	86
75+	59	58	60	75	70	79

In the decennia 1891-1900 and 1901-10 one sees an excess mortality in the country for women in the age class 15-25 and also in the age class 25-35, a slightly higher mortality also in the age class 5-15, while at all other ages the country mortality is lower. In 1921-30 the excess mortality for the country areas has disappeared but in the other age groups there is little change.

We shall not enter into an explanation of this exception to the rule of mortality but merely refer to Hill's investigation of the question of changes in internal migration, the direction of which is different from what it was in the latter half of the nineteenth century, at least in England. In some other countries similar observations have been made. In German statistics unfortunately there is not a sufficiently fine separation into age groups of young adults. Of course, other explanations have been put forward, such for instance as changes in the proportion of immunity through the diminution in the amount of infection in childhood and the corresponding increase of infections in youth, a view

which has been put forward, for example, by Dahl (9) of Norway; other investigators refer to changes in occupation, in particular to the entrance of women into industry. We shall return to this in the second part of our investigation. We believe that in the decline in mortality from tuberculosis changes in population movement besides migration, such as the decline of births, are of some importance.

Here we shall end the preliminary discussion of the numerical structure upon which our further investigation is built, and turn, in Part II, to the interpretation of the epidemiology.

[The bibliography will follow Part II]

A STUDY OF WEIGHT AND STATURE OF NEGRO CITY CHILDREN OF ADOLESCENT AGE

BY ALBERT SIDNEY BECKHAM, PH. D.*

Psychologist, Board of Education, City of Chicago

THIS is an anthropometric study of Negro city children. The study is confined to that period of the child's life which comprises most of the adolescent changes. The period from twelve to sixteen was selected. Hollingworth (4:1) defines adolescence as "That period of life which lies between childhood and adulthood."

It was M. Quetelet, who coined the word anthropometry. Many social and national studies in anthropometry have been made. The stature and weight of the Negro boys and girls in this study are compared with norms from two standard studies, that of Baldwin and the United States Public Health Service. Boas (2:351) has found that growth is more variable with girls than with boys.

The stature and weight of a child are important in his adjustment to life. Then too weight and stature are also related to health. A child may be small, yet remarkable otherwise. Children frequently boast about size for their age. Emerson writes (3:17) "Any investigation of a large number of children will demonstrate that those who are taller and heavier, as a rule have the advantage both in health and mental development."

We are not only concerned in this study with comparing stature and weight of these Negro boys and girls with the norms already found by Baldwin and the United States Public Health Service, but also the index

* The writer wishes to thank the many institutions, agencies, and individuals, who have cooperated in this study. Special mention should be made concerning the Laura Spelman Rockefeller Memorial, the Institute for Juvenile Research, and the Works Progress Administration. A grant from the latter, which supplied the efficient services of Mr. Fred Carter, Mr. Robert Lawrence, and Miss Georgia Williams, is responsible for the completion of this work.

of stature and weight itself. The index says Hrdlička (5:149) "Is the simplest expression of the geometric relation of two dimensions and as such is of much utility for the prompt conveyance of a notion as to the shape or relative size of parts. The index in general is also more permanent than the absolute dimensions of the parts, and therefore more valuable for group comparisons."

The following table supplies such data as: the number of boys at each age from twelve to sixteen; the mean weight and weight range, for each age from twelve to sixteen. The standard deviation for each age is also given. Then the norms found by Baldwin and the United States Public Health Service are given. The difference column is the comparison of the Baldwin and the United States Public Health Service with the mean weight for the Negro boys.

TABLE 1

Boys' weight in pounds

AGE	NO. OF BOYS	PER CENT	MEAN WEIGHT	WEIGHT RANGE	STANDARD DEVIATION	BALDWIN NORMS	DIFFERENCE	U. S. PUBLIC HEALTH SERVICE	DIFFERENCE
12	54	13.64	81.60	60-110	11.5	77.7	+3.90	78.0	+ 3.60
13	80	20.25	96.7	74-160	10.5	88.4	+8.3	85.1	+11.6
14	100	25.31	105.8	80-152	10.56	98.3	+7.5	95.4	+10.4
15	99	25.06	116.9	94-161	12.68	109.4	+7.5	108.4	+ 8.5
16	62	15.69	125.7	95-180	12.6	120.6	+5.1	116.7	+ 9.0
TOTAL	395	99.9	105.34	60-180	11.57	98.88	+6.46	96.72	+ 8.62

The weight of 395 Negro boys is compared with Baldwin norms, and also the weight norms of the United States Public Health Service. There were 54 twelve year old boys in the study. Their mean weight was 81.60 pounds. They range from 60 to 110 pounds, with a standard deviation of 11.5. These twelve year old boys were more than three pounds on the average heavier than both the Baldwin and the United States Public Health Service.

There were 80 boys at the thirteen year level. They were on the average eight pounds heavier than Baldwin's and eleven pounds heavier than the United States Public Health Service.

Boys at the fourteen year level numbered 100. Their mean weight was 105.8 pounds, with a range from 80 to 152 pounds. The standard deviation was 10.6. They were seven pounds heavier than Baldwin's, and ten pounds heavier than the average weight for fourteen year old boys examined by the United States Public Health Service.

There were 99 boys fifteen years of age in this study. Their mean weight was 116 pounds, with a range from 94 to 161 pounds. These boys were seven pounds on the average heavier than Baldwin's and eight pounds heavier than the United State Public Health Service weight standard for fifteen year old boys.

The mean weight of the sixteen year old boys was 125.7 pounds. There were 62 boys at this age level. The mean weight of Baldwin's sixteen year old boys was 120.6 pounds. There was a difference of 5.1 pounds. The United States Public Health Service norm for sixteen year old boys is 116.7 pounds. The boys in this study were on the average heavier than the norms for both the Baldwin and the United States Public Health Service.

The total number of boys from twelve to sixteen was 395. The mean weight of all ages was 105.34. The weight range was from 60 to 180 pounds. The Baldwin norm for all ages was 98.88 pounds. The Baldwin norm was on the average six pounds lighter than these 395 boys. The United States Public Health Service norm was 8.62 pounds lighter on the average.

The 395 boys in this study were, on the average, heavier than the age standards of both the Baldwin and the United States Public Health Service at all ages from twelve to sixteen. Again comparing these 395 boys with the United States Public Health Service, we observe that the difference is less at age twelve and more at age thirteen. The difference is also less at age twelve and more at age thirteen when we compare the boys of this study with the Baldwin age standards.

Table 2 gives the average weight for girls for ages from twelve to sixteen, respectively. The twelve year old girls were heavier on the average than twelve year old boys. The adolescent boy has not as yet caught up with the adolescent girl. There were 58 girls at this age level. The mean weight was 88 pounds, with the range from 60 to 118 pounds. These girls were, on the average, more than four pounds heavier than

TABLE 2

Girls' weight in pounds

AGE	NO. OF GIRLS	PER CENT	MEAN WEIGHT	WEIGHT RANGE	STANDARD DEVIATION	BALDWIN NORMS	DIFFERENCE	U. S. PUBLIC HEALTH SERVICE	DIFFERENCE
12	58	10.94	88.10	60-118	2.60	83.9	+4.20	79.7	+ 8.40
13	80	15.15	96.7	70-160	10.5	96.2	+0.5	89.7	+ 7.0
14	215	40.71	105.2	80-156	10.5	107.2	—2.0	99.4	+ 5.8
15	120	22.72	116.9	92-161	12.6	115.5	+1.4	107.6	+ 9.3
16	55	10.41	125.7	101-186	12.4	120.6	+5.1	113.6	+12.1
TOTAL	528	99.9	106.52	60-186	9.72	104.68	+1.84	98.0	+ 8.5

the Baldwin norms, and eight pounds heavier than the standards of the United States Public Health Service for twelve year old girls.

For age thirteen, there were 80 girls with a mean weight of 96.7 pounds. The mean weight of the thirteen year old girls and thirteen year old boys was the same. Students of adolescence agree that the weight and other advantages held by the girls at age twelve are usually lost around age thirteen. These findings support Hollingworth, (4:6) who says "Then at about the age of twelve girls begin to exceed boys in both weight and stature. The corresponding acceleration of growth does not begin until about the thirteenth birthday in the case of the boys. Girls are typically taller and heavier than boys from twelve to fourteen years of age."

This study reveals that the average weight for the thirteen year old colored boy is the same as the average weight for the thirteen year old colored girl. There was practically no difference between the average weight of the thirteen year old girls examined in this study and the Baldwin age weight standards, but those examined by the United States Public Health Service were seven pounds lighter on the average.

At age fourteen, we have 215 girls with an average weight of 105.2 pounds. The average of the fourteen year old girls was about the same as the fourteen year old boys. The girls had a longer range than the boys. They ranged from 80 to 156 pounds, whereas the boys ranged from 80 to 152 pounds. There was very little difference between the

Baldwin norms and the average for 215 girls in the study. The colored girls were 5.8 pounds heavier on the average than the fourteen year old standard of the United States Public Health Service.

There were 120 girls in this study at age fifteen. Their mean weight was 116.9 pounds. They have the same average weight as the fifteen year old boys. The range is also about the same. These 120 girls were on the average about a pound heavier than Baldwin's weight standard for age fifteen. They were on the average nine pounds heavier than the norms of the United States Public Health Service for age fifteen.

At the sixteenth year, we have 55 girls with a mean weight of 125 pounds. This was also the same as the mean weight of the sixteen year old boys. The sampling here is probably too small. The girls of this age ranged from 101 to 186 pounds. They were heavier on the average than the Baldwin norms and also the sixteen year old standards of the United States Public Health Service.

This study comprised 528 girls. The mean weight for all ages from twelve to sixteen was 106.52. The girls ranged from 60 to 186 pounds, with a standard deviation of 9.72. There was very little difference between the girls in this study and Baldwin norms. The mean weight for the latter for all ages from twelve to sixteen was 104.68 pounds. The mean weight for the United States Public Health Service of all ages from twelve to sixteen was 98 pounds. There was a difference of 8.5 pounds between the latter and the average for the 528 girls in this study.

The girls in this study were, on the average, heavier than those of the United States Public Health Service at all ages from twelve to sixteen. The greatest difference appears at age sixteen. The girls in this study were twelve pounds heavier on the average. The least difference in weight appears at age fourteen. The Negro girls were only five pounds heavier on the average than the United States Public Health Service at this age level.

On the other hand, the girls of the Baldwin norms were heavier than the girls in this study at age fourteen. They were just about the same on the average at age thirteen. The greatest difference between the Baldwin age-weight norms and the girls in this study appears at age sixteen. The colored girls were five pounds heavier on the average than the Baldwin norms at this age level. It is possible that the girls of this study at age sixteen were not as typical as the other age levels in this study.

TABLE 3

Showing cities from which 455 colored boys were measured for stature

CITY	NUMBER	PER CENT
Washington, D. C. (1926-27)	120	26.37
New York City (1928)	42	9.20
Chicago, Illinois (1930-35)	293	64.30
TOTAL	455	99.87

The boys in Table 3 were measured for stature in three cities: Washington, D. C., in the psychological laboratory of Howard University in the years 1926-27; New York City in 1928, and in Chicago in 1930-35. Twenty-six per cent of the boys were measured in D. C. Only nine per cent of the boys were measured in New York City. Chicago furnishes more than sixty-four per cent of these boys. The stadiometer was used in measuring most of these boys.

Observation reveals that these boys are from the large cities. The data do not reveal to what extent these boys are actually city bred or whether they were born and lived for a part of their lives in smaller cities or towns.

In Table 4 the stature of the 455 Negro boys (cf. Table 3) is indicated. Most of these measurements were made on boys in the eighth grade and high school freshmen. A small percentage of these measurements was made by physicians at the Institute for Juvenile Research, representing several school grades.

These boys were measured for ages twelve to sixteen inclusive. The 455 boys in this study are compared in stature with the age standards for stature of Baldwin and the United States Public Health Service.

At the age of twelve, there were 105 boys, with a mean stature of 57.2 inches. The range was from 52 to 60 inches. This average is slightly taller than the Baldwin, and one inch taller than the norms of the United States Public Health Service. The Baldwin norm for twelve year old boys is 56.9 inches, while the age-stature standard of the United States Public Health Service is 56.2 inches for twelve year old boys.

TABLE 4

Showing boys' stature in inches

AGE	NO. OF BOYS	PER CENT	MEAN STATURE	STATURE RANGE	STANDARD DEVIATION	BALDWIN NORMS	DIFFERENCE	U. S. PUBLIC HEALTH SERVICE	DIFFERENCE
12	105	23.07	57.2	52-60	4.8	56.9	+0.30	56.2	+1.0
13	85	18.68	59.3	55-64.4	0.98	59.3	0	58.0	+1.3
14	106	23.29	63.1	55-65	1.02	61.8	+1.3	60.3	+2.8
15	105	23.07	64.1	57-69.1	1.11	64.1	0	62.9	+1.2
16	54	11.86	66.3	59-70	1.04	66.7	—0.4	64.6	+1.7
TOTAL	455	99.9	62.0	52-70	1.79	61.76	+0.24	60.4	+1.6

There were 85 thirteen year old boys in this study. Their mean stature was 59.3 inches, with a standard deviation of 0.98. The range was from 55 to 64.4 inches. There was no difference in the stature of the thirteen year old boys in this study and Baldwin norms for age thirteen. The standard for the United States Public Health Service thirteen year old boys was 1.3 inches shorter than the boys of this study.

At age fourteen, there were 106 boys, with a mean stature of 63.1 inches. These boys were on the average slightly taller than those of Baldwin and the United States Public Health Service. The range in stature for fourteen year old boys was from 55 to 65 inches.

There were 105 boys at the fifteen year level. They had a mean stature of 64.1 inches. There was no average difference in the stature of the fifteen year old boys in this study and those comprising Baldwin norms. These fifteen year old boys ranged in stature from 57 to 69 inches. The fifteen year old boys comprising the United States Public Health Service age standard for height were about an inch shorter than those measured in this study.

At the sixteen year level, there were 54 boys. Their mean stature was 66.3 inches. This was slightly shorter than Baldwin norms, and about an inch taller on the average than the norms for the United States Public Health Service. The stature range for the sixteen year old boys was from 59 to 70 inches.

The mean stature for the 455 Negro boys in this study ranging in ages from twelve to sixteen was 62.0 inches, with a standard deviation of 1.79. The range was from 52 to 70 inches. This is about the same as Baldwin's age norms for stature and more than an inch taller than the stature standard for the United States Public Health Service. The boys in this study were on the average taller than Baldwin norms at ages twelve and fourteen. They were the same as Baldwin norms at ages thirteen and fifteen. They were less than Baldwin standards at age sixteen. The boys of the United States Public Health Service were on the average slightly shorter than the boys of this study, at all ages from twelve to sixteen.

TABLE 5

Showing cities from which 606 colored girls were measured for stature

CITY	NUMBER	PER CENT
Washington, D. C. (1926-27)	250	41.25
New York City (1928)	50	8.25
Chicago, Illinois (1930-35)	306	50.49
TOTAL	606	99.99

There were 606 girls who were measured in this study (Table 5). More than 200 of them were measured in the psychological laboratory at Howard University, from 1926 to 1927. A few of these girls were measured in New York City in 1928. Three hundred and six were measured in Chicago. Most of the Chicago girls were measured at the Du Sable High School. It is clear then, that the girls in the study were city girls. The length of time these girls have lived in the large cities was not determined.

The stature of these 606 girls, from ages twelve to sixteen is shown in Table 6. There were 60 girls twelve years of age. Age nearest birthday was used. The mean stature of the twelve year old girls was 57.3, with a range from 54 to 62 inches. The standard deviation for the twelve year old girls was 1.18. These girls were on the average

TABLE 6

Showing girls' stature in inches

AGE	NO. OF GIRLS	PER CENT	MEAN STATURE	STATURE RANGE	STANDARD DEVIATION	BALDWIN NORMS	DIFFERENCE	U. S. PUBLIC HEALTH SERVICE	DIFFERENCE
12	60	9.6	57.3	54-62	1.18	57.6	—0.3	57.0	+0.3
13	131	21.6	60.5	56-63.4	1.04	60.1	+0.4	59.3	+1.2
14	223	36.8	62.6	56-64.5	1.0	61.8	+0.8	61.1	+1.5
15	131	21.6	62.9	59-65	1.1	62.7	+0.2	62.5	+0.4
16	61	10.1	63.3	59-66	0.94	63.6	—0.3	63.3	0
TOTAL	606	99.7	61.3	54-66	1.05	61.16	+0.1	60.64	+0.6

shorter than Baldwin norms by 0.3 inches. They were, however, taller than the norms of the United States Public Health Service.

There were 131 thirteen year old girls in the study. The mean stature for the thirteen year old girls was 60.5, with a range from 56 to 63.4. The thirteen year old girls were on the average slightly taller than the Baldwin norms, and about an inch taller than the age-stature standards of the United States Public Health Service.

There were 223 girls at the fourteen year level. Their mean stature was 62.6 inches. Their stature range was from 56 to 64.5 inches. These fourteen year old girls were slightly taller than both the Baldwin and the United States Public Health Service age standards for stature.

At age fifteen, there were 131 girls, with a mean stature of 62.9 inches. The stature range for these girls was from 59 to 65 inches. The standard deviation was 1.1. These girls were only a fraction taller on the average than the Baldwin and the United States Public Health Service standards.

There were 61 sixteen year old girls in this study. The mean height of the sixteen year old girls was 63.3 inches. The stature range for this age level was 59 to 66 inches. The standard deviation for year sixteen was 0.94. The mean stature of these girls was the same as the mean height of the United States Public Health Service and 0.3 inches less than the norms found by Baldwin for sixteen year old girls.

The mean stature for all ages from twelve to sixteen was 61.3 inches. The range was from 54 to 66 inches. These 606 girls were on the average only a fraction taller than the Baldwin norms, and 0.6 inches taller than the norms of the United States Public Health Service.

These findings are of significant interest. The twelve year old colored girls were 0.1 inch taller than colored boys.

Let us next observe weight-stature index for boys. Table 7 gives this information for boys from twelve to sixteen years of age.

TABLE 7

Showing weight-stature index of colored boys compared with that of Baldwin and the United States Public Health Service

AGE	NO. OF BOYS	WEIGHT-STATURE INDEX (*Pounds*)	UNITED STATES PUBLIC HEALTH	BALDWIN
12	54	1.42	1.39	1.36
13	80	1.63	1.47	1.49
14	100	1.67	1.58	1.59
15	99	1.82	1.72	1.70
16	62	1.89	1.81	1.80
TOTAL	395	1.68	1.59	1.55

The weight-stature index for twelve year old colored boys is revealed as 1.42 and for thirteen year old colored boys as 1.63. The increase of weight over stature at age twelve is greater than at any age from twelve to sixteen.

With the United States Public Health Service the highest index is at age fourteen. Age twelve also represents the modal index according to Baldwin norms.

Table 8 shows index of stature and weight for colored girls. The index was obtained for 528 girls.

With the colored girls, the modal stature-weight index between twelve and sixteen is at age fourteen. The modal index for the United States Public Health Service was at age thirteen.

Table 8 reveals that the greatest increase of weight over stature for the ages from twelve to sixteen, is in year twelve.

TABLE 8

Showing weight-stature index of colored girls compared with that of Baldwin and the United States Public Health Service

AGE	NO. OF GIRLS	WEIGHT-STATURE INDEX (*Pounds*)	UNITED STATES PUBLIC HEALTH	BALDWIN
12	58	1.53	1.40	1.45
13	80	1.59	1.51	1.60
14	215	1.68	1.63	1.73
15	120	1.85	1.72	1.84
16	55	1.98	1.79	1.89
TOTAL	528	1.92	1.61	1.70

Baldwin (1:23) was a pioneer in growth and age studies. Concerning stature growth he writes as follows:

> From the years six to thirteen and one half, the yearly increment varies from one to eight or nine and one half centimeters. At the age of twelve there is a surprising jump in the increase which reaches as high as twelve centimeters; the rapid increase continues up to seventeen years of age. The increase from six to about seven and one half has no uniformity, and seems to depend on the individual. From the years eight to twelve the usual increase is from seven to nine centimeters. Here, too is the greatest uniformity of increase, that is more boys increase the same number of centimeters than at any other time. In some sporadic cases the increment is as much as ten centimeters. From thirteen to seventeen the increment is larger.

SUMMARY

This study reveals that the city colored boy and girl occupy a favorable position in both weight and stature. The Negro city boy of adolescent age was heavier than Baldwin and the United States Public Health Service norms. The same is true of the colored urban girl of adolescent age.

BIBLIOGRAPHY

1. BALDWIN, B. T. 1914. Physical growth and school progress; *United States Bureau of Education, Bulletin* No. 10 Whole No. 581.
2. BOAS, F. 1912. Growth of children; *Science*, 36; 815.

3. EMERSON, W. R. P. 1922. Nutrition and Growth in Children; Appleton, *New York.*
4. HOLLINGWORTH, L. S. 1928. The Psychology of the Adolescent; Appleton, *New York.*
5. HRDLIČKA, ALEŠ. 1920. Anthropometry. The Wistar Institute of Anatomy and Biology, *Philadelphia.*

THE MEASUREMENT OF VARIATIONS IN ASYMMETRICAL DATA WITH APPLICATIONS TO HEMOGLOBIN STATISTICS OF INFANTS

BY T. E. RAIFORD

The Research Laboratory of the Children's Fund of Michigan, Detroit, and the Mathematics Department, University of Michigan, Ann Arbor

FORTUNATELY many researches from which a sufficient amount of numerical information is obtainable lend themselves to statistical treatment with sufficiently accurate results upon the assumption of a symmetrical distribution of the data about their arithmetic averages. To proceed on this assumption, however, in so far as the use of certain formulae and often-used methods is concerned when the data do not possess such symmetry—usually designated as asymmetrical or skew—leads to serious misinterpretations and poor results. It is desired in this paper to present results from a recent study made in the Research Laboratory of the Children's Fund of Michigan, Detroit, of certain asymmetrical distributions of measurements of the hemoglobin of healthy infants ranging from two weeks to one year in age. The hemoglobins were taken and determined under standardized conditions.

In any discussion of the so-called normal hemoglobin content of the blood at a given age one is interested not only in the average amount of hemoglobin for the children at that age, but also in the amount by which the hemoglobin of the so-called normal child may vary from this average. Three methods will be mentioned here for handling such skew distributions, and the last one will be used in presenting some of the facts brought out by this study.

A method which is often useful and easy of application is that one making use of the cumulative frequency distribution, pictured by the Ogive curve (1) and, among other places, ably presented in a paper by Boyd (2) and illustrated with data from the weight of the spleen. The method, though useful, presents a valid objection. When we speak of a

law of relationship, expressible quantitatively, numerous examples from all branches of science impress us with the important fact that law implies orderliness in behavior. Laws expressible by equations are, as we know from experience, invariably represented by smooth curves. As the statistician is aware, the irregularities in many graphic representations are indication of insufficient numbers. If the purpose of collecting data is to determine, if possible, the law under which the object of study operates then the method suggested fails in that it does not demand this essential property of smoothness. The determination of the algebraic (or transcendental) expression for this growth curve, known as the Ogive, would accomplish this but at the same time defeat the primary value of the method, namely its simplicity and ease of application.

In statistical literature a large class of skew distributions are characterized by the well known Poisson series. Tabulated values of this function by which variations from the average are readily calculated are available (3), but very little use has been made of the method for statistical presentation in current publications. Whether this is due to the general lack of familiarity, in restricted fields of work, with this function and its use, or that the tables are not so generally available, is not evident. Since the classic example of the Poisson series in biological research is that given by Fisher (4) in the data for accuracy of counting with a haemacytometer such as used in many blood studies, we shall use the data of this example in exhibiting the validity of the results by a third method, the one of prime interest in this paper. One of the distinct advantages of this method is that it presents no new basic ideas to the many familiar with the use of tables for the normal curve.

Instead of requiring the use of only one statistical constant, the mean M, as does the Poisson distribution, or two, the mean M and standard deviation σ, as does the normal curve, the third method using Pearson's Type III equation (5), requires three, namely the mean M, the standard deviation σ, and a measure of skewness. Of the many measures of skewness the one best suited to further mathematical treatment is $a_3 = \frac{\Sigma d^3}{N \sigma^3}$, where Σd^3 is the sum of the cubes of the deviations of the individual measurements from the mean. Areas and ordinates for these standard curves of skewness $a_3 = 0, .1, .2 \ldots\ldots 1.1$ have been published by Salvosa (6) those values corresponding to $a_3 = 0$ being of course those for the normal curve.

For the data referred to above and shown in Table 1, the values of M, σ, and a_3 are found to be 4.68, 2.20 and .51 respectively.

TABLE 1

Distribution of yeast cells in the 400 cells of a haemacytometer

NUMBER OF CELLS	f_o	f_p	$f_o - f_p$	f_s	$f_o - f_s$
0	0	4	−4	4	−4
1	20	17	3	17	3
2	43	41	2	41	2
3	53	63	−10	64	−11
4	86	74	12	74	12
5	70	69	1	69	1
6	54	54	0	53	1
7	37	36	1	36	1
8	18	21	−3	21	−3
9	10	11	−1	11	−1
10	5	5	0	6	−1
11	2	2	0	3	−1
12	2	1	1	1	1
13	0	0	0	0	0
14	0	0	0	0	0
15	0	0	0	0	0
16	0	0	0	0	0

With these values the expected frequencies for successive variations from the mean calculated by the use of tables of the Poisson function and also those calculated by use of Salvosa's tables are given in columns headed f_p and f_s respectively. The corresponding differences from the observed frequencies, f_o, are almost identical in the two cases. The χ^2 test for goodness of fit for this law of distribution gives the value of P as between .8 and .9 which means that the law of distribution making use of a_3 is a very good one for these data since a value of $P = .9$, say, means that nine out of ten samples chosen arbitrarily for study would be expected to vary from this graduation by an amount equal to or greater than the one studied (7).

TABLE 2

Grams of hemoglobin per 100 cubic centimeter of blood

Grams of hemoglobin	AGE IN DAYS													
	14—	42—	70—	98—	126—	154—	182—	210—	238—	266—	294—	322—	350—	14—378
6.5	1	1	..	..	..	..	..	..	..	..	..	..	..	2
7	..	1	..	..	..	..	..	..	1	1	2	1	1	7
7.5	1	1	..	..	..	1	1	..	1	2	..	2	1	10
8	..	3	3	..	1	1	1	2	2	1	3	2	4	23
8.5	1	2	2	3	1	..	..	1	2	1	2	1	1	17
9	1	10	11	2	5	1	6	5	9	1	6	4	6	67
9.5	2	15	19	7	8	9	7	12	8	12	13	14	10	136
10	6	43	70	47	31	30	24	35	35	45	51	37	35	489
10.5	..	..	..	..	..	1	2	..	2	..	..	..	..	5
11	10	87	137	135	83	78	104	91	86	100	89	79	73	1152
12	30	68	70	98	121	124	107	103	70	78	65	59	54	1047
13	38	34	13	36	51	63	38	22	26	20	18	10	13	382
14	35	7	3	4	7	4	1	2	4	2	4	1	..	74
15	23	..	1	..	..	..	..	..	..	..	..	..	..	24
16	13	..	..	..	..	..	..	..	..	..	..	..	..	13
17	4	..	..	..	..	..	..	..	..	..	..	..	..	4
18	3	..	..	..	..	..	..	..	..	..	..	..	..	3
	168	272	329	332	308	312	291	273	246	263	253	210	198	3455
M	13.33	11.16	10.92	11.34	11.60	11.67	11.45	11.03	11.20	11.16	11.03	10.98	10.98	11.35
σ	1.93	1.32	1.04	1.00	1.08	1.05	.99	1.03	1.19	1.07	1.17	1.11	1.14	1.25
a_s	—.4	—.4	+.2	.0	—.7	—.5	—.5	—.4	—.4	+.3	—.3	—.6	—.6	+.3

Previous presentations seem to have taken little cognizance of the lack of symmetry in data of hemoglobin studies. The number of grams of hemoglobin per 100 cubic centimeters for each of 3469 samples of blood taken from 364 infants under one year of age is given in Table 2. These infants were studied in the Research Laboratory of the Children's Fund of Michigan, Detroit, Michigan. It should be remarked here that the data for white children and that for the colored children have been combined in this presentation although for other important studies we find justification for separating them (8). Measurements below 10 grams per 100 cubic centimeters were read in half grams and those above 10 grams were read in whole units. These tabulations are given at age intervals of one month (month of 28 days) with a marginal frequency table giving the data for the whole year. The values for the mean M, the standard deviation σ and measure of skewness a_3 are given for each distribution as indicated.

With these statistical constants available it is possible to calculate the expected frequencies for any age group, or rank a child in a given age group, his hemoglobin measurement being given. This would require a complete set of tables. We can, however, illustrate the method as well as answer many important questions from a few values derived from Salvosa's complete tables.

Table 3 presents a tabulation of the percentages of total frequency corresponding to given values of a_3 and below given values of d (d as

TABLE 3

Percentage of distribution below given values of d

d \ a_3	0	.1	.2	.3	.4	.5	.6	.7	.8	.9	1.0	1.1
-3σ	.001	.001	...	...	...	...	...	...	...	...	...	...
-2σ	.023	.020	.017	.014	.011	.008	.005	.003	.001	...	...	...
-1σ	.159	.159	.158	.158	.157	.156	.154	.152	.150	.197	.143	.138
0	.500	.507	.513	.520	.527	.533	.540	.547	.553	.560	.567	.573
1σ	.841	.841	.842	.842	.843	.843	.844	.845	.846	.848	.849	.850
2σ	.977	.975	.972	.970	.968	.966	.964	.962	.960	.959	.958	.956
3σ	.999	.998	.997	.996	.996	.995	.994	.993	.992	.991	.990	.989
4σ	...	...	...	...	...	.999	.999	.999	.998	.998	.998	.997
5σ	...	...	...	...	...	...	...	...	...	...	...	.999

TABLE 4

Value of d, in standard units, below which given percent of distribution lies

α_3 / %	0	.1	.2	.3	.4	.5	.6	.7	.8	.9	1.0	1.1
.5	−2.61	−2.51	−2.41	−2.32	−2.22	−2.12	−2.03	−1.94	−1.85	−1.76	−1.67	−1.58
2.5	−1.96	−1.91	−1.86	−1.81	−1.76	−1.71	−1.66	−1.61	−1.56	−1.51	−1.46	−1.40
25.0	− .67	− .68	− .69	− .70	− .71	− .71	− .72	− .72	− .73	− .73	− .73	− .73
50.0	.00	− .02	− .03	− .05	− .07	− .08	− .10	− .12	− .13	− .15	− .16	− .18
75.0	.67	.67	.66	.64	.63	.62	.61	.60	.58	.57	.55	.54
97.5	1.96	2.01	2.05	2.10	2.14	2.19	2.23	2.27	2.31	2.35	2.38	2.42
99.5	2.61	2.70	2.80	2.90	2.99	3.09	3.18	3.28	3.38	3.41	3.48	3.58

defined earlier and expressed in units of σ), and Table 4 gives a tabulation of values of d below which a given percentage of the frequencies lie.

Consideration will be given to only two distributions from Table 2, one in which a_3 is positive and one in which a_3 is negative, the difference in presentation being that when a_3 is opposite in sign to that shown in Table 3 it is necessary of course to use the d with sign changed also. The cumulative expected frequencies Σf_e are calculated by use of Table 3 at units of 1σ, 2σ, 3σ, from the group average and this of course does not give the same limits as those of the observed for comparison but without introducing interpolation to accomplish this the method is adequate for the present purpose.

The point we wish to make will be made clear if we use only comparisons which can be read directly with comparative accuracy. Of the 272 observed measurements presented in Table 7, seven are below 8.5 grams as compared to nine (using integral numbers) below 8.52 grams. In the same table there are 231 of the 272 measurements observed below 12.5 and the expected number as calculated by use of Table 3 is 230 below 12.48 grams. A bit of arithmetical calculation will show the other comparisons to serve in a very satisfactory way as a method of predicting group frequencies when the average, standard deviation and measure of asymmetry are known.

Defining the probable error of a distribution as the range including 25 per cent of the distribution on either side of the mean (which is the usual definition in case $a_3 = 0$) (9), then from Table 4 we find that for the age group 70-98 one-half of the distribution lies, not between 10.92 $\pm$ .67 (1.04), but between 10.92 — .69 (1.04) and 10.92 + .66 (1.04) and for the age group 42-70 the upper and lower limits are 11.16 + .71 (1.32) and 11.16 — .63 (1.32) respectively. Or again, if we should define as significant any measurement lying in the lowest 2½ per cent or the highest 2½ per cent of the range, that is, the normal range to include the central 95 per cent of the measurements, then for the age group 70-98 a hemoglobin reading would vary significantly if below 10.92 — 1.86 (1.04) grams or above 10.92 + 2.05 (1.04) grams, and for the age group 42-70 normal variation would be between 11.16 — 2.14 (1.32) and 11.16 + 1.76 (1.32) grams.

The results obtained in these illustrations from distributions which are only slightly asymmetrical emphasize the importance of skewness in measuring variation of the kind here presented. A glance at Tables 3

TABLE 5

Age group 70-98 days; $M = 10.92$, $\sigma = 1.04$, $\alpha_3 = .2$

N (1)	$M + N\sigma$ (2)	PERCENT OF DISTRIBUTION BELOW $M + N\sigma$ (Table 3) (3)	TOTAL FREQUENCY BELOW $M + N\sigma$ Σf_s (4) = 329 × (3)
−2	8.84	.017	5.59
−1	9.88	.158	51.98
0	10.92	.513	168.78
1	11.96	.842	277.02
2	13.00	.972	319.79
3	14.04	.997	328.01
4	15.08	1.000	329.00

TABLE 6

Age group 42-70; $M = 11.16$; $\sigma = 1.32$; $\alpha_3 = -.4$

N (1)	$M + N\sigma$ (2)	PERCENT OF DISTRIBUTION BELOW $M + N\sigma$ (Table 4) (3)	TOTAL FREQUENCY BELOW $M + N\sigma$ Σf_s (4) = 272 × (3)
−3	7.20	1 − .996 = .004	1.09
−2	8.52	1 − .968 = .032	8.98
−1	9.84	1 − .843 = .157	42.98
0	11.16	1 − .527 = .473	128.93
1	12.48	1 − .157 = .843	229.57
2	13.80	1 − .011 = .989	269.28
3	15.12	1 − .000 = 1.000	272.00

and 4 shows how greatly results would be affected as the degree of skewness is increased. The ease with which such computations may be made makes the method of practical use.

SUMMARY

The fundamental assumption made at the beginning of the paper should be repeated and emphasized, namely the assumption that the data follow some law which is geometrically represented by a smooth curve. That this is a logical assumption for a given problem is best answered by an expert in the field from which the data are taken, but that this is true for most data is abundantly evident. That the law we have assumed—namely, that from which Tables 3 and 4 have been calculated —is a good one is only answered by some test for Goodness of Fit. Such a test will not be included in this paper, but further work gives evidence that the law here is a valuable one for this problem.

BIBLIOGRAPHY

1. YULE, G. U. An Introduction to the Theory of Statistics. *London,* Charles Griffin and Co., p. 152. 1919.
2. BOYD, EDITH. A method of establishing the probable limits of normal variation in weight of organs. *Anatomical Record,* 62:1, April, 1935.
3. PEARSON, KARL. Tables for Statisticians and Biometricians. *London,* Biometric Laboratory, University College, part I, 3rd ed. pp. 113-124, 1930.
4. FISHER, R. A. Statistical Methods for Research Workers. *London,* Oliver and Boyd, p. 57, 1934.
5. ELDERTON, W. P. Frequency Curves and Correlation. *London,* C. and E. Layton, 1906.
6. SALVOSA, LUIS R. Tables of Pearson's Type III Function. *Annals of Mathematical Statistics.* 1:2, Edwards Bros., *Ann Arbor, Michigan,* May, 1930.
7. TIPPETT, L. H. C. The Methods of Statistics. *London,* Williams and Norgate, p. 66, 1931.
8. MUNDAY, BETTY, SHEPHERD, M. L., EMERSON, L., HAMIL, B. M., POOLE, M. W., and MACY, I. G. Hemoglobin differences in healthy white and Negro infants. *Am. J. Dis. Child.* (In press.)
9. RIETZ, H. L. Handbook of Mathematical Statistics. *Boston,* Houghton Mifflin Co., p. 73, 1924.

SOME PHYSIOLOGICAL PHENOMENA FITTED TO GROWTH EQUATIONS
II. BRAIN POTENTIALS

BY A. P. WEINBACH

Normal Child Development Study of the Department of Diseases of Children, Columbia University, and the Babies' Hospital, New York

THIS paper is a presentation of the data of Lindsley (1) and Smith (2) of the variations of frequency of the Berger rhythm or alpha waves (brain potentials) with age. The data are presented in the form of curves, Figs. 1 and 2. The curves were obtained by fitting the data to the equation representing the growth of bacteria, or cells, or populations, or body weight, etc., during the decelerating phase of growth.

The suggestive reasons for fitting the data for the change of frequency with age to a growth equation are: First, changes in any physiological process with age, such as the one in question, are probably a manifestation of some growth process; and second, the frequency of the rhythm rises rapidly in the early years of life, but approaches a maximum value which is apparently constant throughout adult life.

Lindsley (1) states that "no satisfactory explanation has yet been found..... for the increase in frequency of the waves with age in children, but the constant and somewhat uniform upward trend of the frequency until the adult level is reached at 8 to 10 years of age suggests a developmental process of some sort. Whether myelinization of projection fibers or some growth process is concerned can not be hazarded."

The lower part of Fig. 1 is a plot of the age as abscissae versus the average frequency of the brain potentials as ordinates, plotted on ordinary coordinate paper. These curves have a shape similar to the growth curves of animals, bacteria, population, etc., after the inflection point, that is, when the rate of growth is decelerating (3).

The equation representing the curves of Figs. 1 and 2 is

$$f = f_m - Be^{-kA} \tag{I}$$

where f is the observed frequency of the brain potential in oscillations

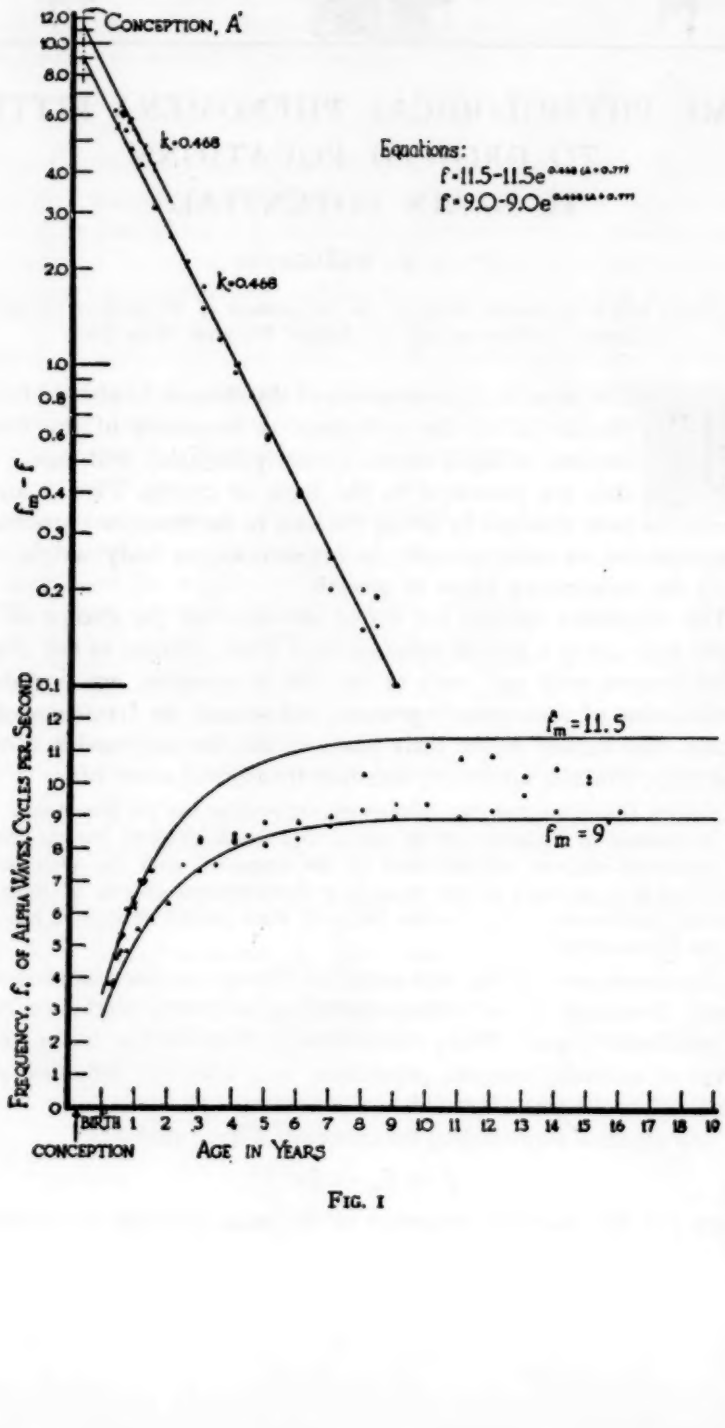
CONCEPTION, A'
k=0.468
k=0.468
Equations:
f=11.5-11.5e
f=9.0-9.0e
f_m=11.5
f_m=9
f_m-f
FREQUENCY, f, OF ALPHA WAVES, CYCLES PER SECOND
BIRTH
CONCEPTION
AGE IN YEARS

FIG. 1

per second at age A years; f_m is the maximum frequency attained in adult life, i.e. the asymptote to the curve; k is the time-rate of decline of change in frequency per year, if age is in years; and B is an age parameter the value of which depends on where the curve meets the age-axis. If age is counted from the point A' where the extrapolated curve meets the age-axis, equation (1) becomes

$$f = f_m - f_m e^{-k(A - A')} \tag{2}$$

since $B = f_m$ when $A = A'$.

The constants in equation (2), f_m, k and A' may be evaluated graphically by trial after first making an assumption for the value of f_m. Equation (1) may be written

$$f_m - f = Be^{-kA} \tag{3}$$

Taking logarithms of both sides

$$ln\,(f_m - f) = ln\,B - kA \tag{4}$$

which is linear in $ln\,(f_m - f)$ and A. If the proper value of f_m is chosen, and $(f_m - f)$ plotted against A on semi-log paper, a straight line should result. If the value of f_m chosen is too high, the resulting curve will be concave upward; and if the value is too low, the curve will be concave downward, while the correct value of f_m will yield a straight line.

The upper part of Fig. 1 shows the lower curves plotted in such a manner. It is seen that for properly chosen values of the maximum frequency attained in adult life the data for frequency versus age apparently follow the growth equation. Two curves are visible in the data of Fig. 1, one having a maximum frequency of 9.0 oscillations per second, the other 11.5 oscillations per second. Lindsley's data is in solid triangles, Smith's in dots.

The slope of the straight line in the figure gives the value of k, the time-rate of decline of change in frequency with age, as shown in equation (4). This value is 0.468 or 46.8 per cent per year for both curves. The constant B may be taken directly from the straight line as it is the intercept on the f axis. It is the value of $(f_m - f)$ when the age is zero counted from birth. However, it is more appropriate to obtain the value of A' in equation (2). This is given as the age when the growth curve is extrapolated back to the age-axis. It is the age of the individual when the frequency of the brain potentials is zero. There-

fore, it is the value of A when f equals zero, or when $(f_m - f)$ equals f_m. By extrapolating the straight line to the point where $(f_m - f)$ equals f_m the value of A' may be read directly on the age-axis. A' is minus 0.77 years for both curves.

The age at which a given frequency is reached or at which a certain fraction of the adult frequency is reached may be determined as derived by Brody (3) for weight-growth curves.

Equation (2) may be written

$$f = f_m - f_m e^{-kA} \tag{5}$$

where A is measured from the point where the curve meets the age-axis

Then

$$\frac{f_m - f}{f_m} = e^{-kA}$$

$$ln \frac{f_m - f}{f_m} = -kA$$

$$A = -\frac{1}{k} ln \frac{(f_m - f)}{f_m}$$

whence

$$A = -\frac{1}{k} ln \left(1 - \frac{f}{f_m}\right) \tag{6}$$

If one wishes to determine the age at which half the adult frequency is reached, f is replaced by $0.5f_m$ in equation (6).

$$A = -\frac{1}{k} ln \left(1 - \frac{0.5f_m}{f_m}\right)$$

$$A = -\frac{ln\, 0.5}{k}$$

In Fig. 1 the age at which half the adult frequency has been reached is

$$A = \frac{0.693}{0.468}$$

$= 1.48$ years counted from the point where the curve meets the age-axis, minus 0.77 years.

Fig. 2 includes the average and maximum range of frequencies obtained at the various ages and gives curves having a maximum adult rhythm of 8, 9, 10, 11 and 12 oscillations per second. These curves

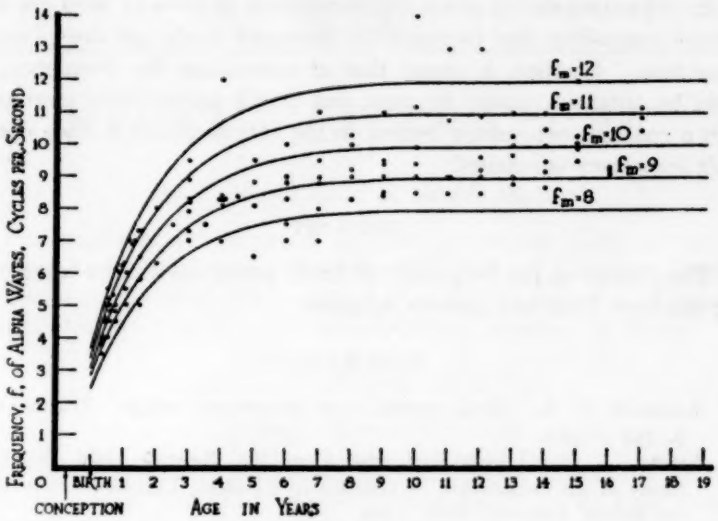

FIG. 2

seem to cover the band of variation of frequency. Longitudinal studies of one individual may give a curve from which the adult rhythm can be predicted or the rhythm at any age.

Three interesting points are brought out in Figs. 1 and 2. First, the change of frequency of brain potentials with increasing age apparently follows a growth curve similar to that obtained for other growth phenomena.

Second, the rapidity of approach to the maximum or adult frequency may be determined from the curves, and this fractional decline in the time-rate of increase in frequency of brain potentials is a constant, probably a genetic constant, varying for different species but essentially constant for each species. This constant is 0.468 or 46.8 per cent per year for all the curves of Figs. 1 and 2.

Third, the curve of increase in frequency with age when extrapolated back to zero frequency meets the age-axis approximately at conception. That is, the value of A' in equation (2) is approximately minus 0.77 years from birth. It is not possible to decide whether this is an accidental finding of no significance or a true representation of the course of growth of brain potentials. No definite conclusions can be made until studies of the frequencies of potentials in fetuses have been

made. If extrapolation gives the true course of growth, then the mechanisms controlling the increase of frequency with age are present at conception. Further, it shows that at conception the frequency, if it could be obtained, would be zero, but would immediately start to rise with a constant percentage decline in the rate at which it rises until the adult frequency is reached.

SUMMARY

The change in the frequency of brain potentials (alpha waves) with age has been fitted to a growth equation.

REFERENCES

(1) LINDSLEY, D. B.: Brain potentials in children and adults. *Science*, vol. 84, p. 354 (1936).

(2) SMITH, J. R.: Unpublished data from the Normal Child Development Study of the Department of Diseases of Children, Columbia University and the Babies' Hospital, *New York*.

(3) BRODY, S.: *Missouri Agricultural Experiment Station Research Bulletins* 97, 101 and 102, (1927).

RECENT LITERATURE

USEFUL IN THE STUDY OF HUMAN BIOLOGY

In this department will be noticed the books and reprints which are currently received at the Editorial Office. Publications intended for notice here should be addressed to Dr. Raymond Pearl, Department of Biology, School of Hygiene and Public Health, 1901 East Madison Street, Baltimore, Maryland, U. S. A.

I. EVOLUTION AND GENETICS

1. *Evolution—General Principles*

CARPENTER, F. M., J. W. FOLSOM, E. O. ESSIG, A. C. KINSEY, C. T. BRUES, M. W. BOESEL, and H. E. EWING. Insects and arachnids from Canadian amber. *University of Toronto Studies, Geological Series* No. 40, pp. 7-62, 1937. [Bibliographic footnotes.]

CLARK, AUSTIN H. Eogenesis—the origin of animal forms. *Acta Biotheoretica*, Vol. 3, pp. 181-194, 1937. [Bibliography of 7 titles.]

DAVIES, A. MORLEY. Evolution and Its Modern Critics. *London* (Thomas Murby and Co.), 1937. Pp. xii + 277. 7⅜ × 4⅞ inches. 7s. 6d. net. [Bibliography of 45 titles.]

DOBZHANSKY, THEODOSIUS. Genetics and the Origin of Species. *New York* (Columbia University Press), 1937. Pp. xvi + 364. 9 × 6 inches. $3.60. [Bibliography of 28 pages.]

FENTON, CARROLL L. Life Long Ago. The Story of Fossils. *New York* (Reynal and Hitchcock), 1937. Pp. x + 287 + 14 plates. 9¼ × 6¾ inches. $3.50.

GILMORE, CHARLES W. On the detailed skull structure of a crested hadrosaurian dinosaur. *Proceedings of the United States National Museum*, Vol. 84, pp. 481-491, 1937. [Bibliographic footnotes.]

GOLDSCHMIDT, RICHARD. Ascaris: The Biologist's Story of Life. *New York* (Prentice-Hall), 1937. Pp. ix + 390. 8 × 5½ inches. $3.25.

KINSEY, ALFRED C. An evolutionary analysis of insular and continental species. *Proceedings of the National Academy of Sciences*, Vol. 23, pp. 5-11, 1937. [Bibliography of 17 titles.]

KINSEY, ALFRED C. Supra-specific variation in nature and in classification. *American Naturalist*, Vol. 71, pp. 206-222, 1937.

SHULL, A. FRANKLIN. The needs of the mimicry theory. *Science*, Vol. 85, pp. 496-498, 1937. [4 bibliographic footnotes.]

2. *Human Evolution*

BACKMAN, GASTON. Die Entstehung des Menschenfusses. *Lunds Universitets Årsskrift.* N. F. Avd. 2, Bd. 32, Nr. 11. *Lund* (C. W. K. Gleerup); *Leipzig* (Otto Harrassowitz), 1937. Pp. 77. 10¼ × 7⅜ inches. Kr. 4:50 (paper). [Bibliography of 3 pages.]

JENKS, ALBERT E. Minnesota's Browns Valley Man and Associated Burial Artifacts. *Memoirs of the American Anthropological Association,* Number 49. *Menasha, Wis.* (American Anthropological Association), 1937. Pp. 49 + 8 plates. 9½ × 6⅝ inches. 60 cents (paper).

MACCURDY, GEORGE GRANT [Editor.] Early Man as Depicted by Leading Authorities at the International Symposium, The Academy of Natural Sciences, Philadelphia, March 1937. Introduction by John C. Merriam. *Philadelphia* (J. B. Lippincott Co.), 1937. Pp. 362 + 27 plates. 9 × 6 inches. $5.00. [Bibliographic footnotes.]

ŠKERLJ, B. *Pithecanthropus* and *Homo. Zeitschrift für Rassenkunde,* Bd. 6. pp. 338-339, 1937.

3. *Prehistory and Archaeology*

COLTON, HAROLD S., and LYNDON L. HARGRAVE. Handbook of Northern Arizona Pottery Wares. *Museum of Northern Arizona, Bulletin* No. 11. *Flagstaff* (Northern Arizona Society of Science and Art), 1937. Pp. xiv + 267. 8¼ × 5¼ inches. $4.00. [Bibliography of 5 pages.]

HOWARD, EDGAR B. The Folsom Problem in North America. *Zeitschrift für Rassenkunde,* Bd. 6, pp. 331-336, 1937. [Bibliography of 1 page.]

MCGREGOR, J. C. Winona Village. A XIIth Century Settlement with a Ball Court near Flagstaff, Arizona. *Museum of Northern Arizona, Bulletin* No. 12. *Flagstaff* (Northen Arizona Society of Science and Art), 1937. Pp. 53. 8¼ × 5¼ inches. 75 cents (paper). [Bibliography of 27 titles.]

4. *Genetics—General Principles*

ALLEN, CHARLES E. Haploid and diploid generations. *American Naturalist,* Vol. 71, pp. 193-205, 1937.

GOODALE, H. D. Can artificial selection produce unlimited change? *American Naturalist,* Vol. 71, pp. 433-459, 1937. [Bibliography of 6 titles.]

GORER, P. A. The genetic and antigenic basis of tumor transplantation. *Journal of Pathology and Bacteriology,* Vol. 44, pp. 691-697, 1937. [Bibliography of 13 titles.]

GORER, P. A. The genetics of cancer in the mouse. *Lancet,* Vol. 233, pp. 461-462, 1937. [Bibliography of 21 titles.]

JONES, DONALD F. Somatic segregation and its relation to atypical growth. *Genetics,* Vol. 22, pp. 484-522, 1937. [Bibliography of 1¾ pages.]

NAGAI, MARY, and GORDON L. LOCHER. Production of mutations by neutrons. *Nature,* Vol. 140, p. 111, 1937.

SINNOTT, EDMUND W. The genetic control of developmental relationships. *American Naturalist*, Vol. 71, pp. 113-119, 1937.

SINNOTT, EDMUND W. The relation of gene to character in quantitative inheritance. *Proceedings of the National Academy of Sciences*, Vol. 23, pp. 224-227, 1937. [Bibliography of 2 titles.]

5. *Human Heredity*

ATZENHOEFER, D. R., and D. CECIL RIFE. A pair of tubercular twins. *Journal of Heredity*, Vol. 27, pp. 265-267, 1937.

COTTERMAN, CHARLES W. The detection of sex-linkage in families collected at random. *Ohio Journal of Science*, Vol. 37, pp. 75-81, 1937. [Bibliography of 3 titles.]

COTTERMAN, CHARLES W. Indication of unit factor inheritance in data comprising but a single generation. *Ohio Journal of Science*, Vol. 37, pp. 127-140, 1937. [Bibliography of 4 titles.]

COTTERMAN, CHARLES W., and LAURENCE H. SNYDER. Studies in human inheritance XVII: The gene-frequency analysis of double recessive inheritance involving one autosomal and one sex-linked gene substitution. *Genetica*, Vol. 19, pp. 537-552, 1937. [Bibliography of 10 titles.]

FUKUOKA, GORÔ. Studies on Japanese twins. II. Anthropometric and psychometric studies on Japanese twins. *Contributions to the Genetics of the Japanese Race*, August, 1937. Pp. 9-47. [Bibliography of 4¼ pages.]

HERMAN, MORRIS, and IRVING M. DERBY. The blood groups and M-N types in mental diseases. *Journal of Immunology*, Vol. 33, pp. 87-99, 1937. [Bibliography of 28 titles.]

HYMAN, HARRIET SYLVIA. The development of the agglutinogens M and N in newborn infants with notes on the agglutinogens A and B. *Abstracts of Doctors' Dissertations, Ohio State University*, No. 21, pp. 187-193, 1937.

KOMAI, TAKU. Studies on Japanese twins. I. Review of literature on twin studies in Japan. *Contributions to the Genetics of the Japanese Race*, August, 1937. Pp. 1-8. [Bibliography of 1½ pages.]

SCHADE, H. Zur endogenen Entstehung von Gliedmassendefekten. *Zeitschrift für Morphologie und Anthropologie*, Bd. 36, pp. 375-381 + 1 folding chart + 4 plates, 1937. [Bibliography of 13 titles.]

SCHADE, H. Erbbiologische Bestandsaufnahme. *Fortschritte der Erbpathologie, Rassenhygiene*, Jahrg. 1, pp. 37-48, 1937. [Bibliography of 2½ pages.]

SNYDER, LAURENCE H. The present status of the medico-legal applications of blood grouping. *Eugenical News*, Vol. 21, pp. 45-50, 1936.

SNYDER, LAURENCE H., and CHAS. W. COTTERMAN. Further extensions of the gene-frequency methods of analysing human inheritance. *Genetics*, Vol. 22, pp. 209-210, 1937.

SYNDER, LAURENCE H., and D. F. DAVIDSON. Studies in human inheritance XVIII. The inheritance of taste deficiency to di-phenyl-guanidine. *Eugenical News*, Vol. 22, pp. 1-2, 1937. [Bibliography of 5 titles.]

6. *Eugenics*

ASTEL. Verwirklichung rassenhygienischer Wohnungspolitik in Thueringen. *Bericht der 12. Versammlung der Internationalen Federation Eugenischer Organisationen. Konferenzsitzungen vom 15. bis 20. Juli 1936, Scheveningen, Holland*, pp. 7-12, 1937.

ASTEL. Fortschritte der Erbbestandsaufnahme in Deutschland und Thueringen. *Bericht der 12. Versammlung der Internationalen Federation Eugenischer Organisationen. Konferenzsitzungen vom 15. bis 20. Juli 1936, Scheveningen, Holland*, p. 12, 1937.

HANSEN, KLAUS. Das Norwegische Sterilisierungsgesetz von 1934 und seine praktischen Ergebnisse. *Bericht der 12. Versammlung der Internationalen Federation Eugenischer Organisationen. Konferenzsitzungen vom 15. bis 20. Juli 1936, Scheveningen, Holland*, pp. 37-39, 1937.

VON HOFSTEN, NILS. Sterilization in Sweden. *Bericht der 12. Versammlung der Internationalen Federation Eugenischer Organisationen. Konferenzsitzungen vom 15. bis 20. Juli 1936, Scheveningen, Holland*, pp. 39-41, 1937.

KOPP, MARIE E. The nature and operation of the German eugenical programme. *Marriage Hygiene*, May 1937, pp. 279-287. [Bibliography of 19 titles.]

MJÖEN, J. A. Weitere Richtlinien für eine rassenhygienische Bevölkerungspolitik. *Bericht der 12. Versammlung der Internationalen Federation Eugenischer Organisationen. Konferenzsitzungen vom 15. bis 20. Juli 1936, Scheveningen, Holland*, pp. 4-7, 1937.

POPENOE, P. Progress of sterilization in the United States. *Bericht der 12. Versammlung der Internationalen Federation Eugenischer Organisationen. Konferenzsitzungen vom 17. bis 20. Juli 1936, Scheveningen, Holland*, pp. 42-45, 1937.

RÜDIN, E. Die neuen rassenhygienischen Gesetze in Deutschland vom medizinischen Standpunkt aus. *Bericht der 12. Versammlung der Internationalen Federation Eugenischer Organisationen. Konferenzsitzungen vom 15. bis 20. Juli 1936, Scheveningen, Holland*, pp. 13-24, 1937.

RUTTKE. Erbpflege in der deutschen Gesetzgebung. *Bericht der 12. Versammlung der Internationalen Federation Eugenischer Organisationen. Konferenzsitzungen vom 15. bis 20. Juli 1936, Scheveningen, Holland*, pp. 25-31,1937.

SCHADE, H. Die Häufigkeit des Schwachsinns in einer geschlossenen bäuerlichen Bevölkerung, erhoben bei einer erbbiologischen Bestandsaufnahme. *Zeitschrift für induktive Abstammungs- und Verebungslehre*, Ed. 73, pp. 577-579, 1937.

WAD, GUNNAR. Danish sterilization law. *Bericht der 12. Versammlung der Internationalen Federation Eugenischer Organisationen. Konferenzsitzungen vom 15. bis 20. Juli 1936, Scheveningen, Holland*, pp. 32-36, 1937.

II. GROUP BIOLOGY

1. *Environment of Man*

COLTON, HAROLD S. Some notes on the original condition of the Little Colorado River: A side light on the problems of erosion. *Museum Notes (Museum of Northern Arizona)*, Vol. 10, pp. 17-20, 1937. [7 bibliographic footnotes.]

DARBY, HUGH H., E. R. F. JOHNSON, and GEORGE W. BARNES. Studies on the absorption and scattering of solar radiation by the sea. Spectrographic and photo-electric measurements. *Carnegie Institution of Washington Publication* No. 475, pp. 191-205 + 1 plate, 1937. [Bibliography of 15 titles.]

DUFRENOY, J., and M.-L. Les parcs nationaux aux Etats-Unis. *Mémoires de la Société de Biogéographie*, pp. 251-255 + 5 plates. [No date. Probably 1937.]

FRAPS, G. S., and J. F. FUDGE. Chemical composition of soils of Texas. *Texas Agricultural Experiment Station, Bulletin* No. 549, July, 1937. Pp. 87. [Bibliography of 61 titles.]

GABBARD, L. P., and C. A. BONNEN. Statistics of Texas Agriculture. *Texas Agricultural Experiment Station, Circular* No. 80. *Division of Farm and Ranch Economics*, October, 1937. Pp. 103.

HUBBARD, GEORGE D. The Geography of Europe. *New York and London* (D. Appleton-Century Co.), 1937. Pp. xii + 876 + 1 folding map. 8¾ × 6 inches. $5.00. [Bibliography at end of some chapters.]

MANRESA, MIGUEL. General observations on animal husbandry in India. *The Philippine Agriculturist*, Vol. 26, pp. 341-376, 1937. [Bibliographic footnotes.]

PICKWELL, GAYLE. Weather. Natural History Studies. *Los Angeles* (Hugh F. Newman and Co.), 1937. Pp. x + 170. 11½ × 9 inches. $3.00. [List of additional reading of 24 titles.]

SEARS, PAUL B. This Is Our World. *Norman* (University of Oklahoma Press), 1937. Pp. xi + 292. 7¾ × 5¼ inches. $2.50.

STUART, WILLIAM. The Potato, Its Culture, Uses, History and Classification. Fourth Edition Revised. *Philadelphia* (J. B. Lippincott Co.), 1937. Pp. xv + 508 + 4 plates. 8¼ × 5½ inches. $3.00. [Bibliography at end of each chapter.]

U. S. DEPARTMENT OF AGRICULTURE. Yearbook of Agriculture, 1937. *Washington* (Government Printing Office), 1937. Pp. 1497. 9 × 5¾ inches. $2.00.

U. S. DEPARTMENT OF AGRICULTURE. Agricultural Statistics, 1937. *Washington* (Government Printing Office), 1937. Pp. 486. 9¼ × 5¾ inches. 50 cents (paper).

VISHER, STEPHEN S. Aids to the Student of Conservation. Review and Thought-provoking Questions concerning Our Natural Resources and Their Conservation. Edited by Parkins and Whitaker. *New York* (John Wiley and Co.); *London* (Chapman and Hall), 1937. Pp. 32. 10¾ × 8¼ inches. 25 cents (paper).

WILLCOX, O. W. ABC of Agrobiology. The Quantitative Science of Plant Life and Plant Nutrition for Gardners, Farmers and General Readers. *New York* (W. W. Norton and Co.), 1937. Pp. 323. 8 × 5½ inches. $2.75.

WOOLDRIDGE, S. W., and R. S. MORGAN. The Physical Basis of Geography. An Outline of Geomorphology. *New York* (Longmans, Green and Co.), 1937. Pp. xxi + 445. 8½ × 5½ inches. $4.80. ["Bibliographic Notes" of 6½ pages.]

2. *Public Health and Hygiene*

CENTRAL HANOVER BANK AND TRUST CO. The Public Health Nurse. *New York* (Department of Philanthropic Information, Central Hanover Bank and Trust Co.), 1937. Pp. 54. 9 × 6 inches.

CH'EN, C. C. Tsing Hsien and the public health movement in China. *Milbank Memorial Fund Quarterly*, Vol. 15, pp. 380-390, 1937.

COLLINS, SELWYN D., and CLARK TIBBITTS, with the assistance of ARCH B. CLARK, and ELEANOR L. RICHIE. Research Memorandum on Social Aspects of Health in the Depression. Bulletin 36. *New York* (Social Science Research Council, 230 Park Ave.), 1937. Pp. xiii + 192. 9 × 6 inches. $1.00 (paper). [Bibliographic footnotes throughout.]

DOWNES, JEAN, and CLARA R. PRICE. Tuberculosis control in the Mulberry District of New York City. *Milbank Memorial Fund Quarterly*, Vol. 15, pp. 319-347, 1937. [Bibliographic footnotes.]

DRELOT, G. J. Health Conditions in New York City during the Past Quarter of a Century with Reports of Leading Causes of Death and of Cases of Infectious Diseases during the Years 1934, 1935 and 1936. *New York* (New York Tuberculosis and Health Association), 1937. Pp. [30]. 10⅞ × 8⅛ inches.

GLADSTON, IAGO. Maternal Deaths—The Ways to Prevention. *New York* (Commonwealth Fund); *London* (Oxford University Press), 1937. Pp. [10] + 115. 8¼ × 5½ inches. 75 cents (cloth); 50 cents (paper); 25 percent discount on lots of 10 or more. [Bibliographic footnotes.]

HILBERT, HORTENSE. Nursing services for mothers and children as part of a balanced public health nursing program. *American Journal of Public Health*, Vol. 27, pp. 875-879, 1937. [1 bibliographic reference.]

INDIA. Annual Report of the Public Health Commissioner with the Government of India for 1935, Volume I. *Delhi* (Manager of Publications), 1937. Pp. viii + 276 + 4 maps + 7 charts. 9¾ × 6½ inches. Rs. 2 or 3s. 6d. (paper).

LEAGUE OF NATIONS. Nutrition. Final Report of the Mixed Committee of the League of Nations on the Relation of Nutrition to Health, Agriculture and Economic Policy. *New York* (Columbia University Press), 1937. Pp. 327. 9½ × 6¼ inches. $2.00 (paper). [Bibliographic footnotes.]

[MACNALTY, SIR ARTHUR S.] On the State of the Public Health. Annual Report of the Chief Medical Officer of the Ministry of Health for the Year 1936. *London* (H. M. Stationery Office), 1937. Pp. iv + 254. 9⅝ × 6 inches. 4s. net.

MCCOWN, ALBERT. The general plan and objectives of a maternal and child health program. *Southern Medical Journal*, Vol. 30, pp. 750-754, 1937.

NEW HAVEN, CONNECTICUT, Department of Health. Annual Report 1936. *New Haven*, 1937. Pp. 31.

ROCKEFELLER FOUNDATION, INTERNATIONAL HEALTH DIVISION. Annual Report 1936. *49 West 49th St., New York*, 1937. Pp. viii + 278. 8⅝ × 5¾ inches.

3. *Migration*

CONSEIL SANITAIRE MARITIME ET QUARANTENAIRE D'EGYPTE. Rapport sur le Pèlerinage du Hedjaz de l'Année de l' Hégire 1355 (A.D. 1937). *Alexandrie* (Société de Publications Égyptiennes), 1937. Pp. 147 + 5 plates + 5 folding tables. 12½ × 9¼ inches. Free (paper).

RUSSELL, E. S. Fish migrations. *Biological Reviews*, Vol. 12, pp. 320-327, 1937. [Bibliography of 39 titles.]

4. *Population*

ALLEE, W. C., and GERTRUDE EVANS. Certain effects of numbers present on the early development of the purple sea-urchin, *Arbacia punctulata*: A study in experimental ecology. *Ecology*, Vol. 18, pp. 337-345, 1937. [Bibliography of 17 titles.]

ALLEE. W. C., and GERTRUDE EVANS. Some effects of numbers present on the rate of cleavage and early development in *Arbacia*. *Biological Bulletin*, Vol. 72, pp. 217-232, 1937. [Bibliography of 5 titles.]

ALLEE, W. C., and GERTRUDE EVANS. Further studies on the effect of numbers on the rate of cleavage in eggs in *Arbacia*. *Journal of Cellular and Comparative Physiology*, Vol. 10, pp. 15-28, 1937. [Bibliography of 11 titles.]

BUREAU OF THE CENSUS. Estimated Population of the United States as of July 1, 1937, with Distribution by States for 1933, 1936, and 1937. *U. S. Department of Commerce, Washington, D. C.*, December 3, 1937, pp. 2.

BUCHSBAUM, RALPH. Chick tissue cells and *Chlorella* in mixed cultures. *Physiological Zoology*, Vol. 10, pp. 373-379 + 3 plates, 1937. [Bibliography of 9 titles.]

BUXTON, P. A. The effect of climatic conditions upon populations of insects. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, Vol. 26, pp. 325-364, 1933. [Bibliography of 2 pages.]

BUXTON, P. A. Studies on populations of headlice (*Pediculus humanus capitis*: *anoplura*): I. *Parasitology*, Vol. 28, pp. 92-97, 1936. [Bibliography of 3 titles.]

BUXTON, P. A. The numbers of males and females in natural populations of head-lice (*Pediculus*: *anoplura*). *Proceedings of the Royal Entomological Society of London*, Series A, Vol. 12, pp. 12-14, 1937. [1 bibliographic reference.]

CHINNERY, E. W. P. Census and population. *Oceania*, Vol. 3, pp. 214-217, 1932.

ELLIOTT, ALFRED M. Effects of certain organic acids and protein derivatives on the growth of *Colpidium*. *Archiv für Protistenkunde*, Bd. 84, pp. 471-494, 1935. [Bibliography of 25 titles.]

ELLIOTT, ALFRED M. Effects of carbohydrates on growth of *Colpidium*. *Archiv für Protistenkunde*, Bd. 84, pp. 155-174, 1935. [Bibliography of 10 titles.]

ESTADOS UNIDOS MEXICANOS, SECRETARIA DE LA ECONOMIA NACIONAL, Direccion General de Estadistica. La Reforma Agraria en Mexico. *Mexico, D.F.* (Departmento Autonomo de Publicidad y Propaganda), 1937. Pp. 22 of text + 20 charts. 9½ × 12½ inches.

GREEN, H. W., and LEON E. TRUESDELL. Census Tracts in American Cities (Census Tract Manual). A Brief History of the Census Tract Movement, with an Outline of Procedure and Suggested Modifications. Revised Edition. *Department of Commerce, Bureau of the Census. Washington,* July, 1937. Pp. 8.

GREENWOOD, MAJOR. On the value of royal commissions in sociological research, with special reference to the birth-rate. *Journal of the Royal Statistical Society,* Vol. 100, pp. 396-414, 1937.

HALL, R. P. On the relation of hydrogen-ion concentration to the growth of *Euglena anabaena* var. *minor* and *E. deses. Archiv für Protistenkunde,* Bd. 79, pp. 239-248, 1933. [Bibliography of 10 titles.]

HALL, R. P., and J. B. LOEFER. On the supposed utilization of inorganic nitrogen by the colorless cryptomonad flagellate, *Chilomonas paramecium. Protoplasma,* Vol. 26, pp. 321-330, 1936. [Bibliography of 16 titles.]

HAMILTON, W. J., JR. The biology of microtine cycles. *Journal of Agricultural Research,* Vol. 54, pp. 779-790, 1937. [Bibliography of 13 titles.]

JAHN, THEO. L. Studies on the physiology of the euglenoid flagellates. V. The effect of certain carbohydrates on the growth of *Euglena gracilis* Klebs. *Archiv für Protistenkunde,* Bd. 86, pp. 237-250, 1935. [Bibliography of 11 titles.]

JANSSEN, JOHN F., JR. First report of sardine tagging in California. *California Fish and Game,* Vol. 23, pp. 190-204, 1937. [Bibliography of 5 titles.]

JOHNSON, C. G. The relative values of man, mouse, and domestic fowl as experimental hosts for the bed-bug, *Cimex lectularius* L. *Proceedings of the Zoological Society of London,* Series A, Vol. 107, pp. 107-126, 1937. [Bibliography of 16 titles.]

JOHNSON, DAVID F. Growth of *Glaucoma ficaria* Kahl in cultures with single species of other microorganisms. *Archiv für Protistenkunde,* Bd. 86, pp. 359-378, 1936. [Bibliography of 37 titles.]

KUCZYNSKI, ROBERT R. Colonial Population. *New York* (Oxford University Press), 1937. Pp. xiv + 101. 8¼ × 5½ inches. $1.75. [Bibliographic footnotes.]

LOEFER, J. B., and R. P. HALL. Effect of ethyl alcohol on the growth of eight protozoan species in bacteria-free cultures. *Archiv für Protistenkunde,* Bd. 87, pp. 123-130, 1936. [Bibliography of 9 titles.]

PERCIVAL, P. E. The future of the British race. *National Life,* 1937. Pp. (of reprint) 6.

WRIGHT, SEWALL. The distribution of gene frequencies in populations. *Science,* Vol. 85, p. 504, 1937.

WRIGHT, SEWALL. The distribution of gene frequencies in populations. *Proceedings of the National Academy of Sciences,* Vol. 23, pp. 307-320, 1937. [Bibliography of 9 titles.]

5. *Mortality and General Vital Statistics*

BUREAU OF THE CENSUS. Number of Deaths from Puerperal Causes, by Race and Age: United States, 1935. *Vital Statistics—Special Reports, Washington, D. C.*, August 27, 1937, Vol. 3, No. 34, pp. 161-162.

BUREAU OF THE CENSUS. Number of Deaths (Exclusive of Stillbirths) from Selected Causes, by Certain Subdivisions of the First Year of Life: 1935. *Vital Statistics—Special Reports, Washington, D. C.*, September 13, 1937, Vol. 3, No. 35, pp. 163-168.

BUREAU OF THE CENSUS. The Interchange of Birth and Death Nonresident Transcripts Between States. *Vital Statistics—Special Reports, Washington, D. C.*, October 2, 1937, Vol. 3, No. 37, pp. 175-179.

BUREAU OF THE CENSUS. Fatal Accidents in the United States: 1935. *Vital Statistics—Special Reports, Washington, D. C.*, October 18, 1937, Vol. 3, No. 38, pp. 181-212.

BUREAU OF THE CENSUS. Number of Deaths (Exclusive of Stillbirths) from Each Cause, by Sex, Race, and Age: United States, 1935. *Vital Statistics—Special Reports, Washington, D. C.*, October 28, 1937, Vol. 3, No. 39, pp. 213-265.

BUREAU OF THE CENSUS. Number of Births and Deaths According to Place of Residence in Each State: 1935. *Vital Statistics—Special Reports, Washington, D. C.*, October 29, 1937, Vol. 3, No. 40, pp. 267-269.

BUREAU OF THE CENSUS. Survey of State Certificates of Birth, Stillbirth, and Death. *Vital Statistics—Special Reports, Washington, D. C.*, November 20, 1937, Vol. 3, No. 41, pp. 271-330.

BUREAU OF THE CENSUS. General Instructions to Transcribers for Copying Birth, Death, and Stillbirth Certificates: 1937. *Vital Statistics—Special Reports, Washington, D. C.*, December 9, 1937, Vol. 3, No. 42, pp. 331-338.

BUREAU OF THE CENSUS. State Summaries for 1936. *Vital Statistics—Special Reports, Washington, D. C.*, October 13, 1937, Vol. 4, No. 1, p. 1.

BUREAU OF THE CENSUS. Vital Statistics Summary for Connecticut: 1936. *Vital Statistics—Special Reports, Washington, D. C.*, October 13, 1937, Vol. 4, No. 2, pp. 3-17.

BUREAU OF THE CENSUS. Vital Statistics Summary for Delaware: 1936. *Vital Statistics—Special Reports, Washington, D. C.*, October 22, 1937, Vol. 4, No. 3, pp. 19-33.

BUREAU OF THE CENSUS. Vital Statistics Summary for Indiana: 1936. *Vital Statistics—Special Reports, Washington, D. C.*, November 2, 1937, Vol. 4, No. 4, pp. 35-55.

BUREAU OF THE CENSUS. Vital Statistics Summary for Maine: 1936. *Vital Statistics—Special Reports, Washington, D. C.*, November 4, 1937, Vol. 4, No. 5, pp. 57-72.

BUREAU OF THE CENSUS. Vital Statistics Summary for Montana: 1936. *Vital Statistics—Special Reports, Washington, D. C.*, November 9, 1937, Vol. 4, No. 6, pp. 73-90.

BUREAU OF THE CENSUS. Vital Statistics Summary for New Hampshire: 1936. *Vital Statistics—Special Reports, Washington, D. C.*, November 10, 1937, Vol. 4, No. 7, pp. 91-106.

BUREAU OF THE CENSUS. Vital Statistics Summary for Nevada: 1936. *Vital Statistics—Special Reports, Washington, D. C.*, November 12, 1937, Vol. 4, No. 8, pp. 107-122.

BUREAU OF THE CENSUS. Vital Statistics Summary for Utah: 1936. *Vital Statistics—Special Reports, Washington, D. C.*, November 15, 1937, Vol. 4, No. 9, pp. 123-138.

BUREAU OF THE CENSUS. Vital Statistics Summary for Maryland: 1936. *Vital Statistics—Special Reports, Washington, D. C.*, November 18, 1937, Vol. 4, No. 10, pp. 139-154.

BUREAU OF THE CENSUS. Vital Statistics Summary for Michigan: 1936. *Vital Statistics—Special Reports, Washington, D. C.*, November 23, 1937. Vol. 4, No. 11, pp. 155-176.

BUREAU OF THE CENSUS. Vital Statistics Summary for Minnesota: 1936. *Vital Statistics—Special Reports, Washington, D. C.*, November 27, 1937, Vol. 4, No. 12, pp. 177-196.

BUREAU OF THE CENSUS. Vital Statistics Summary for Vermont: 1936. *Vital Statistics—Special Reports, Washington, D. C.*, November 30, 1937, Vol. 4, No. 13, pp. 197-212.

BUREAU OF THE CENSUS. Vital Statistics Summary for New Jersey: 1936. *Vital Statistics—Special Reports, Washington, D. C.*, December 2, 1937, Vol. 4, No. 14, pp. 213-232.

BUREAU OF THE CENSUS. Vital Statistics Summary for North Dakota: 1936. *Vital Statistics—Special Reports, Washington, D. C.*, December 6, 1937, Vol. 4, No. 15, pp. 233-250.

BUREAU OF THE CENSUS. Vital Statistics Summary for Washington: 1936. *Vital Statistics—Special Reports, Washington, D. C.*, December 8, 1937, Vol. 4, No. 16, pp. 251-268.

BUREAU OF THE CENSUS. Vital Statistics Summary for Rhode Island: 1936. *Vital Statistics—Special Reports, Washington, D. C.*, December 10, 1937, Vol. 4, No. 17, pp. 269-284.

CONNECTICUT STATE DEPARTMENT OF HEALTH. Eighty-eighth Registration Report of Births, Marriages, Divorces and Deaths for the Year Ended December 31, 1935. *Hartford*, 1937. Pp. 308. 9 × 5¾ inches.

DUBLIN, LOUIS I., and ALFRED J. LOTKA. Twenty-Five Years of Health Progress. A Study of the Mortality Experience Among the Industrial Policyholders of the Metropolitan Life Insurance Company 1911 to 1935. *New York* (Metropolitan Life Insurance Co.), 1937. Pp. xi + 611. 9¼ × 5⅞ inches.

DUNN, HALBERT L. The Collection of Fatal Traffic Accident Statistics. *Bureau of the Census. Vital Statistics—Special Reports, Washington, D. C.*, September 13, 1937, Vol. 3, No. 36, pp. 169-174.

HAGENBEEK, J. H. Het Moederschap in Overijssel. Een Onderzoek naar de Verloskundige Voorziening en de Zuigelingenzorg in der Provincie Overijssel. *Zwolle* (Firma H. Tulp), 1936. Pp. [14] + 148 + 2 folding maps. 9½ × 6⅜ inches. [Bibliography of 2½ pages.]

HOLMES, S. J. The Negro's Struggle for Survival. A Study in Human Ecology. *Berkeley* (University of California Press), 1937. Pp. xii + 296. 9¼ × 6 inches. $3.00. [Bibliography of 28 pages.]

REGISTRAR-GENERAL'S Statistical Review of England and Wales for the Year 1936. (New Annual Series, No. 16). Tables. Part I. Medical. *London* (H. M. Stationery Office), 1937. Pp. iv + 406. 9⅝ × 6 inches. 6s. net (paper).

SCHMID, CALVIN F. Mortality Trends in the State of Minnesota. *Minneapolis* (University of Minnesota Press), 1937. Pp. ix + 325. 9 × 6 inches. $3.50. [Bibliography of 12¼ pages.]

TANDY, ELIZABETH C. Infant and Maternal Mortality Among Negroes. *U. S. Department of Labor, Children's Bureau. Bureau Publication* No. 243. *Washington* (Government Printing Office), 1937. Pp. 34. 9⅛ × 5⅞ inches. 10 cents (paper).

6. *Morbidity and Epidemiology*

BRITTEN, ROLLO H. Risk of mortality among persons with chronic disease. *Milbank Memorial Fund Quarterly*, Vol. 15, pp. 303-318, 1937. [Bibliographic footnotes.]

EDGE, P. GRANVILLE. The incidence and distribution of malaria in British colonial possessions. *Supplement to the Tropical Diseases Bulletin*, November, pp. 3-12, 1937.

PELLER, S. The clinical state of the tonsils in cases of cancer. *Folia Oto-Laryngologica Orientalia*, Vol. 3, pp. 189-197, 1936. [Bibliography of 1 title.]

WHEELER, RALPH E. Impairments in a rural population. *Milbank Memorial Fund Quarterly*, Vol. 15, pp. 371-380, 1937.

WOOFTER, T. J., JR. Replacement rates in the productive ages. *Milbank Memorial Fund Quarterly*, Vol. 15, pp. 348-354, 1937. [Bibliographic footnotes.]

YOUNG, CHARLES N. Accident Statistics of the Federal Government. With Introduction and Summary Presented by the Author on May 28, 1937, before a Meeting of the Federal Accident Statisticians. *Washington, D. C.* (Central Statistical Board), 1937. Pp. v + 141. 10½ × 8⅛ inches.

7. *Natality, Fecundity, Fertility*

ASHLEY-MONTAGU, M. F. Coming Into Being Among the Australian Aborigines. A Study of the Procreative Beliefs of the Native Tribes of Australia. Foreword by B. Malinowski. *London* (George Routledge and Sons), 1937. Pp. xxxvi + 362 + 5 plates. 10 × 6⅛ inches. 21s. net. [Bibliography of 7 pages.]

BLATZ, W. E., N. CHANT, M. W. CHARLES, M. I. FLETCHER, N. H. C. FORD, A. L. HARRIS, J. W. MACARTHUR, M. MASON, and D. A. MILLICHAMP. Collected Studies on the Dionne Quintuplets. *St. George's School for Child Study, The University of Toronto. Toronto* (University of Toronto Press), 1937. Pp. [8] + 206 + 39 plates + 13 tables + 9 charts + 5 folding charts. 9 × 6 inches. $4.00.

Buxton, P. A. Breeding rates of domestic rats trapped in Lagos, Nigeria, and certain other countries. *Journal of Animal Ecology*, Vol. 5, pp. 53-66, 1936. [Bibliography of 23 titles.]

Halevy, H. S. Age du marriage, natalité, intervalles des accouchements et avortements chez les Juifs en Palestine. *Revue "Osé"*, Vol. 12, pp. 1-8, 1937. [Bibliography of 5 titles.]

Komai, Taku, and Gôrô Fukuoka. Frequency of multiple births among the Japanese and related peoples. *American Journal of Physical Anthropology*, Vol. 21, pp. 433-447, 1936. [Bibliography of 14 titles.]

Marchant, James. The birth-rate. Past reports on the decline. Case for a Royal Commission. *The Times, London, England*, March 19, 1937.

Marchant, James. The birth-rate. Degeneracy and decline. Problems for a Royal Commission. *The Times, London, England*, April 5, 1937.

Martin, W. J. Studies in the declining birth-rate, England and Wales. I. The Northern counties. 2. Summary of results for all areas. *Journal of Hygiene*, Vol. 37, pp. 489-511, 1937.

Peller, Sigismund. Der Abortus in Österreich. *Wiener medizinische Wochenschrift*, Nr. 38, 1937. Pp. (of reprint) 8. [Bibliography of 5 titles.]

Roy, D. N. On the rôle of blood in ovulation in *Aëdes aegypti* Linn. *Bulletin of Entomological Research*, Vol. 27, pp. 423-429, 1936. [Bibliography of 4 titles.]

Woke, P. A. Comparative effects of the blood of different species of vertebrates on egg-production of *Aëdes aegypti* Linn. *American Journal of Tropical Medicine*, Vol. 17, pp. 729-745, 1937. [Bibliography of 8 titles.]

Woke, P. A. Comparative effects of the blood of man and of canary on egg-production of *Culex pipiens* Linn. *Journal of Parasitology*, Vol. 23, pp. 311-313, 1937.

Woke, P. A. Effects of various blood fractions on egg production of *Aëdes aegypti* Linn. *American Journal of Hygiene*, Vol. 25, pp. 372-380, 1937. [Bibliography of 14 titles.]

8. *Birth Control*

Birth Control International Information Centre. Birth control: the position to-day. *News Letter*, No. 8, May/August, pp. 1-11, 1937.

Gamble, Clarence J., and Gilbert W. Beebe. The clinical effectiveness of lactic acid jelly as a contraceptive. *American Journal of Medical Sciences*, Vol. 194, pp. 79-84, 1937. [Bibliography of 3 titles.]

Goodman, Herman. Calendar Love. The Truth About Birth Control. *New York* (Hermes Publishing Co.), 1937. Pp. 55. 8 × 5½ inches. 50 cents (paper).

Irwin, Rita, and Clementina Paolone. Practical Birth Control. A Guide to Medically Approved Measures for the Married. *New York* (Robert M. McBride and Co.), 1937. Pp. xxiii + 172. 7½ × 5¼ inches. $1.75.

9. *Marriage and Divorce*

Chaddock, Robert E. Methods of estimating proportional frequencies of divorce. *American Sociological Review*, Vol. 2, pp. 398-405, 1937.

LAWRIE, MACPHERSON. Love, Marriage and Divorce. *London* (Methuen and Co.), 1937. Pp. [8] + 198. 7⅜ × 4⅞ inches. 5s. net.

SAVORGNAN, FRANCO. L'Estinzione dei matrimoni. *Annali di Statistica*, Vol. 1, 1937. Pp. (of reprint) 7.

SCHWIDETZKY, I. Heiratskreise in Oberschlesien. *Zeitschrift für Rassenkunde*, Bd. 6, pp. 311-331, 1937. [Bibliographic footnotes.]

III. BEHAVIOR

1. *Racial and Genetic Psychology*

BIERENS DE HAAN, J. A. Über den Begriff des Instinktes in der Tierpsychologie. *Folia Biotheoretica*, No. 11, pp. 1-16, 1937. [Bibliography of 13 titles.]

COWLES, JOHN T. Food-Tokens as Incentives for Learning by Chimpanzees. *Comparative Psychology Monographs*, Volume 14, Number 5. Serial Number 71. *Baltimore* (Johns Hopkins Press), 1937. Pp. 96. 10 × 5⅞ inches. $1.75 (paper). [Bibliography of 25 titles.]

GRINDLEY, G. C. The Intelligence of Animals. *London* (Methuen and Co.), 1937. Pp. vii + 70. 6⅝ × 4¼ inches. 2s. 6d. net. ["Suggested Reading" of 8 titles.]

LORENZ, KONRAD. Über den Begriff der Instinkthandlung. *Folia Biotheoretica*, No. 11, pp. 17-50, 1937. [Bibliography of 59 titles.]

RUSSELL, E. S. Instinctive behavior and bodily development. *Folia Biotheoretica*, No. 11, pp. 67-76, 1937. [Bibliography of 25 titles.]

VERLAINE, L. Qu'est-ce que l'instinct? *Folia Biotheoretica*, No. 11, pp. 51-66, 1937. [Bibliography of 14 titles.]

2. *Individual Psychology*

BUROS, OSCAR K. Educational, Psychological and Personality Tests of 1936. Including a Bibliography and Book Review Digest of Measurement Books and Monographs of 1933-36. *New Brunswick, N. J.* (School of Education, Rutgers University), 1937. Pp. 141. 9 × 6 inches. 75 cents (paper).

CHASE, STUART. The Tyranny of Words. *New York* (Harcourt, Brace and Co.), 1938. Pp. xiv + 396. 5½ × 8 inches. $2.50. [Bibliography of 26 titles.]

EFRON, DAVID, and JOHN P. FOLEY, JR. Gestural behavior and social setting. *Zeitschrift für Sozialforschung*, Jahrg. 6, pp. 152-161, 1937.

FOLEY, J. P., JR. The fallacy of hypostatization. *Journal of General Psychology*, Vol. 16, pp. 491-493, 1937. [Bibliographic footnotes.]

FOLEY, J. P., JR. Concerning psychological systems. *Journal of General Psychology*, Vol. 17, pp. 161-164, 1937. [Bibliography of 3 titles.]

FOLEY, J. P., JR. Factors conditioning motor speed and tempo. *Psychological Bulletin*, Vol. 34, pp. 351-397, 1937. [Bibliography of 110 titles.]

FORD, ADELBERT. Perceptive errors in time judgments of behavior. *Journal of Experimental Psychology*, Vol. 20, pp. 528-552, 1937. [Bibliography of 11 titles.]

JEANS, SIR JAMES. Science and Music. *New York* (The Macmillan Co.); *Cambridge* (University Press), 1937. Pp. x + 258 + 10 plates. 8½ × 5⅝ inches. $2.75.

KLEITMAN, N., F. J. MULLIN, N. R. COOPERMAN, and S. TITELBAUM. Sleep Characteristics. How They Vary and React to Changing Conditions in the Group and the Individual. *Chicago* (University of Chicago Press), 1937. Pp. vi + 87. 8½ × 6 inches. $1.00. [Bibliography of 5 titles.]

SEASHORE, CARL E. [Editor.] Objective Analysis of Musical Performance. *University of Iowa Studies. Studies in the Psychology of Music*, Volume IV. *Iowa City* (University Press), 1936. Pp. 379. 9¼ × 6 inches. $2.00 (paper); $2.50 (bound). [Bibliography at end of each chapter.]

SIMPSON, HELEN, MARGARET COLE, DOROTHY L. SAYERS, JOHN RHODE, E. R. PUNSHON, FRANCIS ILES, and FREEMAN W. CROFTS. The Anatomy of Murder. Famous Crimes Critically Considered by Members of the Detection Club. *New York* (The Macmillan Co.), 1937. Pp. vii + 336. 8⅜ × 5⅝ inches. $2.50.

SYZ, HANS. Recovery from loss of mnemic retention after head trauma. *Journal of General Psychology*, Vol. 17, pp. 355-387, 1937. [Bibliography of 91 titles.]

3. *Psychiatry*

BURROW, TRIGANT. The organismic factor in disorders of behavior. *Journal of Psychology*, Vol. 4, pp. 333-341, 1937. [Bibliography of 17 titles.]

DAVENPORT, CHARLES B. Causes of retarded and incomplete development. *American Association on Mental Deficiency*, Vol. 41, pp. 208-214, 1936.

ELIASBERG, W. Problèmes de la race et la psychothérapie dans leur rapport particulier avec psychothérapie des névroses chez les Juifs. *Revue "Osé"*, Vol. 12, pp. 9-16, 1937. [Bibliographic footnotes.]

THOMPSON, CHARLES B. The relation of psychosis, mental defect and personality types to crime. *Journal of Criminal Law and Criminology*, Vol. 28, pp. 1-22, 1937. [Bibliography of 10 titles.]

4. *History and Biography*

ALLEE, W. C. Obituary of William Morton Wheeler. *Bulletin of the Ecological Society of America*, Vol. 18, pp. 13-14, 1937.

BARTUCZ, LAJOS. Die Anthropologie in Ungarn. *Zeitschrift für Rassenkunde*, Bd. 6. pp. 254-255, 1937.

BROWN, F. MARTIN. America's Yesterday. *Philadelphia* (J. B. Lippincott Co.), 1937. Pp. 319 + 32 plates. 9 × 6 inches. $3.50.

BRUES, CHARLES T. Professor William Morton Wheeler, with a list of his published writings. *Psyche*, Vol. 44, pp. 61-96, 1937.

v. EICKSTEDT, E. FRHR. Geschichte der anthropologischen Namengebung und Klassifikation (unter Betonung der Erforschung von Südasien). II. Teil, 2. Hälfte. *Zeitschrift für Rassenkunde*, Bd. 6, pp. 151-210, 1937. [Bibliography of 1¼ pages.]

FAIRCHILD, DAVID, ELMER D. MERRILL, and THOMAS BARBOUR. The Treub Foundation of Buitenzorg, Java. *Science*, Vol. 86, pp. 96-97, 1937.

GEISER, SAMUEL W. Naturalists of the Frontier. With a Foreword by Herbert S. Jennings. *Dallas* (University Press in Dallas, Southern Methodist University), 1937. Pp. 341. 9 × 6 inches. $3.00.

v. GLASENAPP, HELMUTH. Die Inder in Trinidad und Guayana. *Zeitschrift für Rassenkunde*, Bd. 6, pp. 307-311, 1937.

HEKTOEN, LUDVIG, and ALBERT L. BARROWS. Summary statement of activities of the National Research Council, 1936-1937. *Science*, Vol. 86, pp. 315-320, 1937.

HENDERSON, L. J., THOMAS BARBOUR, F. M. CARPENTER, and HANS ZINSSER. William Morton Wheeler. *New England Museum of Natural History*, No. 84, pp. 12-17, 1937.

KOFOID, C. A. Has biology advanced in the last twenty-five years? *Proceedings of the Twenty-fifth Anniversary Celebration of the Inauguration of Graduate Studies at The University of Southern California*, pp. 229-235, 1937.

NEUBERT, F. Die bidhaften Sprichwörter der Romanen. *Zeitschrift für Rassenkunde*, Bd. 6, p. 337, 1937. [1 bibliographic footnote.]

REIFF, HENRY. The United States and International Administrative Unions. Some Historical Aspects. *International Conciliation*, No. 332, pp. 627-657, 1937. [Bibliographic footnotes.]

ROUSSEAU, JACQUES. La Botanique Canadienne à l'Époque de Jacques Cartier. *Contributions du Laboratoire de Botanique de l'Université de Montréal*, No. 28. *New York* (Henry G. Fielder, 89 Chambers St.); *Montréal* (Institut Botanique, Université de Montréal); *Leipzig* (T. Oswald Weigel), 1937. Pp. 86. 9 × 6¼ inches. 50 cents (paper). [Bibliographic footnotes.]

SEMMES, RAPHAEL. Captains and Mariners of Early Maryland. *Baltimore* (Johns Hopkins Press), 1937. Pp. xvi + 856. 9½ × 6¾ inches. $5.00. [Bibliography of 6¼ pages.]

TAMMES, TINE. Die Bedeutung von Dr. Maria Anna van Herwerden für die Genetik und die Eugenik. *Genetica*, Vol. 18, pp. 3-9, 1936. [List of writings of Dr. Maria Anna van Herwerden.]

TRUE, ALFRED C. A History of Agricultural Experimentation and Research in the United States 1607-1925. Including A History of the United States Department of Agriculture. *U. S. Department of Agriculture, Miscellaneous Publication* No. 251. *Washington* (Government Printing Office), 1937. Pp. vi + 321. 9 × 5¾ inches. 25 cents. [Bibliography of 327 titles.]

U. S. DEPARTMENT OF LABOR, CHILDREN'S BUREAU. A Historical Summary of State Services for Children in New York. *Bureau Publication* No. 239, Part 2. *Washington* (Government Printing Office), 1937. Pp. v + 37. 9¼ × 5⅞ inches. 10 cents (paper).

5. *Sociology, Law, Politics and Religion*

BEWS, J. W. Life as a Whole. *New York* (Longmans, Green and Co.), 1937. Pp. ix + 347. 8½ × 5½ inches. $6.00. [Bibliography of 5 pages.]

BLUMENTHAL, ALBERT. Culture Consists of Ideas. *Marietta, Ohio* (Marietta College Press), 1937. Pp. 20. 9¼ × 6⅛ inches. 20 cents (paper). [Bibliographic footnotes.]

BURROW, TRIGANT. The law of the organism. A neuro-social approach to the problems of human behavior. *American Journal of Sociology*, Vol. 42, pp. 814-824, 1937. [Bibliographic footnotes.]

CARNEGIE ENDOWMENT FOR INTERNATIONAL PEACE. The World Situation. President Roosevelt's Address of October 5 on the World Political Situation. Statement on the Far Eastern Crisis, Issued by the Department of State, October 6. Japanese Government Statements of August 15 and October 9. Letter addressed to The New York Times by former Secretary of State Henry L. Stimson. American Foreign Policy Statement of July 16 and Comments of Foreign Governments. *International Conciliation*, November, 1937, No. 334. *New York*. Pp. 709-797. 7¾ × 5 inches. 5 cents (paper).

CARNEGIE ENDOWMENT FOR INTERNATIONAL PEACE. Twenty Years of Bolshevism, by a Correspondent of the London Times. Present Conditions in Russia, by Harold Denny. Germany and Italy, Speeches of Benito Mussolini and Adolf Hitler at Berlin, September 28, 1937. Addresses by Admiral Horthy, Regent of Hungary. *International Conciliation*, December, 1937, No. 335. *New York*. Pp. 803-850. 7¾ × 5 inches. 5 cents (paper).

CATTELL, R. B., J. COHEN, and R. M. W. TRAVERS [Editors.] Human Affairs. *New York and London* (Macmillan and Co.), 1937. Pp. xi + 360 + 17 portraits. 8½ × 5½ inches. $4.25.

COCHRAN, JOHN J. Has Repeal Failed? Results prove conclusively it has not. The course of wisdom now would be to protect the youth, perfect control systems, and strictly and impartially enforce the Laws. *Congressional Record*. Pp. 9. 1937.

COX, EUGENE A. Fascism: Evolution in reserve. *Lewiston Morning Tribune, Lewiston, Idaho*, September 19, 1937.

GARDNER, ELLA. Development of a Leisure-time Program in Small Cities and Towns. *U. S. Department of Labor, Children's Bureau. Bureau Publication* No. 241. *Washington* (Government Printing Office), 1937. Pp. 12. 9⅛ × 4⅞ inches. 5 cents (paper).

GLAISTER, JOHN, and JAMES C. BRASH. Medico-Legal Aspects of the Ruxton Case. *Baltimore* (William Wood and Co.), 1937. Pp. xvi + 384. 9¾ × 7⅛ inches. $6.00.

GLUECK, SHELDON, and ELEANOR. Later Criminal Careers. *New York* (Commonwealth Fund); *London* (Oxford University Press), 1937. Pp. xi + 403. 9¼ × 6¼ inches. $3.00.

HOOVER, HERBERT. The crisis and the political parties. *Atlantic Monthly*, September, 1937. Pp. (of reprint) 15.

RADIN, PAUL. Primitive Religion: Its Nature and Origin. *New York* (The Viking Press), 1937. Pp. x + 322. 8½ × 5¾ inches. $3.50. [Bibliographic "Notes" of 7½ pages.]

SELLIN, THORSTEN. Research Memorandum on Crime in the Depression. Bulletin 27. *New York* (Social Science Research Council, 230 Park Ave.), 1937.

Pp. vii + 133. 9 × 6 inches. $1.00 (paper). [Bibliographic footnotes throughout.]

SIGERIST, HENRY E. Socialized Medicine in the Soviet Union. *New York* (W. W. Norton and Co.), 1937. Pp. 378 + 16 plates. 8½ × 5⅝ inches. $3.50. [Bibliographic footnotes.]

U. S. DEPARTMENT OF LABOR, CHILDREN'S BUREAU. Home Play and Play Equipment for the Preschool Child. *Bureau Publication* No. 238. *Washington* (Government Printing Office), 1937. Pp. iii + 20. 9⅛ × 5⅞ inches. 10 cents (paper).

WHETTEN, NATHAN L., and WALTER C. MCKAIN, JR. A Sociological Analysis of Relief and Non-Relief Families in a Rural Connecticut Town. *Storrs Agricultural Experiment Station, Bulletin* No. 219. *Storrs, Conn.* (Connecticut State College), 1937. Pp. 79. 9 × 6 inches. [Bibliography of 27 titles.]

WILBUR, RAY L., and ARTHUR M. HYDE. The Hoover Policies. *New York* (Charles Scribner's Sons), 1937. Pp. x + 667. 9¼ × 6½ inches. $3.00.

6. *Economics*

BANCO DE LA NACION ARGENTINA. Annual Report and Balance Sheet for the Financial Year 1936. *Buenos Aires,* 1937. Pp. 96. 9 × 6⅛ inches.

BEAN, L. H., P. H. BOLLINGER, and O. V. WELLS. Nonagricultural Income as a Measure of Domestic Demand. *U. S. Department of Agriculture. Agricultural Adjustment Administration, Program Planning Division. Washington* (Government Printing Office), 1937. Pp. iv + 45. 9¼ × 5⅞ inches (paper).

BETTS, RONALD E. Sales of Cotton for Future Delivery, 1925-26 to 1935-36. *U. S. Department of Agriculture, Miscellaneous Publication* No. 282. *Washington* (Government Printing Office), 1937. Pp. 42. 9⅛ × 5⅞ inches. 10 cents (paper).

BONNEN, C. A., and B. H. THIBODEAUX. A Description of the Agriculture and Type-of-Farming Areas in Texas. *Texas Agricultural Experiment Station, Bulletin* No. 544. June, 1937. Pp. 91.

BRAND, R. H. Gold: A world economic problem. *International Conciliation,* No. 333, pp. 663-677, 1937.

BROWN, ALEX., and SONS. What Happened. An Attempt to Determine the Causes of the Recent Business Recession and the Serious Decline in Market Values of Securities. *Baltimore,* 1937. Pp. 18. 8⅝ × 6 inches.

COWLES COMMISSION FOR RESEARCH IN ECONOMICS. Report of Third Annual Research Conference on Economics and Statistics, June 28 to July 23, 1937. *Colorado Springs,* 1937. Pp. 108. 9 × 6 inches.

DU PONT, LAMMOT. Industry's Outlook. Address delivered before *The Congress of American Industry,* December 7, 1937, New York City. *Wilmington* (E. I. Du Pont de Nemours and Co.), 1937. Pp. 7. 10 × 4 inches.

FISHER, ARNE. A brief note on seasonal variation. *Journal of Accountancy,* September, 1937. Pp. (of reprint) 28.

GAMBLE, PHILIP L. Taxation of Insurance Companies. *Special Report of the State Tax Commission,* No. 12. *Albany,* 1937. Pp. 195. 9 × 5¾ inches. [Bibliography of 17 pages.]

LARSON, OLAF F. Beet Workers on Relief in Weld County, Colorado. *Research Bulletin* No. 4. Issued by Cooperative Plan of Rural Research between Colorado State Agricultural Experiment Station and Rural Section, Division of Social Research, Federal Works Progress Administration. *Washington*, May, 1937. Pp. [35].

MORGENSTERN, OSKAR. Removal of the exchange control. The example of Austria. *International Conciliation*, No. 333, pp. 678-689, 1937.

NEW YORK STATE TAX COMMISSION. 1937 Amendments to the Personal Income Tax Law (Article 16 of the Tax Law) and Unincorporated Business Income Tax Law (Article 16-A of the Tax Law). *State of New York, Department of Taxation and Finance, Manual* 37-A. *Albany, N. Y.*, 1937. Pp. 13. 9 × 5¾ inches.

NEW YORK STATE TAX COMMISSION. Motor Fuel Tax Law of New York with Regulations and General Instructions. *New York State Tax Bulletin*, Vol. 22, No. 8. *Albany, N. Y.*, 1937. Pp. 29. 9 × 5¾ inches.

NEW YORK STATE TAX COMMISSION. Estate Tax Law Article 10-C, in effect September 1, 1930. *New York State Tax Bulletin*, Vol. 22, No. 9. *Albany, N. Y.*, 1937. Pp. 30. 9 × 5¾ inches.

PAISH, SIR GEORGE. Peace and permanent prosperity. *International Conciliation*, No. 333, pp. 690-705, 1937.

STAUBER, B. R., and M. M. REGAN. A Graphic Summary of the Value of Farm Property. (Based Largely on the Census of 1930 and 1935). *U. S. Department of Agriculture. Miscellaneous Publication* No. 263. *Washington* (Government Printing Office), 1937. Pp. ii + 20. 9⅛ × 5⅞ inches. 5 cents (paper).

U. S. DEPARTMENT OF AGRICULTURE. Monthly Indexes of Nonagricultural and National Income. Statistical Supplement to "Nonagricultural Income as a Measure of Domestic Demand". *Agricultural Adjustment Administration, Program Planning Division. Washington* (Government Printing Office), 1937. Pp. 9. 9¼ × 5⅞ inches (paper).

7. *Education*

[BACHMAN, GEORGE W.] Report of the Director of the School of Tropical Medicine of The University of Puerto Rico under the auspices of Columbia University, for the Year Ending June, 1937. *San Juan* (University of Puerto Rico); *New York* (Columbia University), 1937. Pp. 67. 9 × 6 inches.

BOUSFIELD, M. O. The Negro home and the health education program. *Journal of Negro Education*, July, 1937, pp. 513-518.

CIPRIANI, L. Die Wissenschaft vom Menschen in der Sowjet-Union. *Zeitschrift für Rassenkunde*, Bd. 6, pp. 251-252, 1937.

v. EICKSTEDT, E. FRHR. Zur derzeitigen Stellung der Anthropologie. *Zeitschrift für Rassenkunde*, Bd. 6, pp. 242-243, 1937.

FĂCĂOARU, I. Die "Ganzheitsanthropologie" und das Studium des Menschen in Rumänien. *Zeitschrift für Rassenkunde*, Bd. 6, pp. 248-250, 1937.

FRANKENBERGER, Z. Die Anthropologie in der Tschechoslowakei. *Zeitschrift für Rassenkunde*, Bd. 6, pp. 252-254, 1937.

GREENWOOD, MAJOR, and E. LEWIS-FANING. A statistical contribution to the history of examinations of medical students. *Lancet*, Vol. 233, pp. 277-280, 1937.

GROVES, ERNEST R. Teaching marriage at the University of North Carolina. *Social Forces*, Vol. 10, pp. 87-96, 1937.

GRUENBERG, BENJAMIN C. School science and public needs. *Nation's Schools*, Vol. 20, No. 3, 1937. Pp. (of reprint) 3.

KUMARIS, I. Die Anthropologie in Griechenland. *Zeitschrift für Rassenkunde*, Bd. 6, pp. 245-246, 1937.

LEBLANC, THOMAS J. What the medical student should be taught about vital statistics. *American Journal of Public Health*, Vol. 27, pp. 1273-1276, 1937.

MACNIDER, WM. DEB. The biologically minded physician. *Science*, Vol. 86, pp. 109-114, 1937.

MARETT, R. R. Anthropology at Oxford. *Zeitschrift für Rassenkunde*, Bd. 6, pp. 243-244, 1937.

RIDDLE, OSCAR. The relative claims of natural science and of social studies to a core place in the secondary school curriculum. A.—for natural science. *Science Education*, Vol. 21, pp. 65-71, 1937.

RIDDLE, OSCAR. A national association of biology teachers. *The Teaching Biologist*, Vol. 6, No. 8, 1937. Pp. (of reprint) 3.

ŠKERLJ, B. Anthropologie in Jugoslavien. *Zeitschrift für Rassenkunde*, Bd. 6, pp. 246-247, 1937.

STRANG, RUTH M., RUTH E. GROUT, and DOROTHY G. WIEHL. Evaluation of a rural school health education project. *Milbank Memorial Fund Quarterly*, Vol. 15, pp. 355-370, 1937.

U. S. DEPARTMENT OF LABOR, CHILDREN'S BUREAU. Está ud. Educando a su Niño a ser Feliz? Lecciones Sobre el Cuidado del Niño. *Publicación* No. 202. *Washington* (Government Printing Office), 1937. Pp. v + 57. 9¼ × 5⅞ inches.

WRZOSEK, A. Anthropologie in Polen. *Zeitschrift für Rassenkunde*, Bd. 6, pp. 247-248, 1937.

8. *Ethnology, Cultural Anthropology, Travel and Exploration*

CHAPMAN, OLIVE M. Across Cyprus. With a Foreword by The Viscount Mersey. *London* (John Lane, The Bodley Head), 1937. Pp. 255 + 34 plates + 1 folding map. 8½ × 5⅜ inches. 15s. net.

GHURYE, G. S. Disposal of human placenta (with special reference to India). *Journal of the University of Bombay*, Vol. 6, Part 1, July 1937. Pp. (of reprint) 65 + 1 folding chart. [Bibliographic footnotes.]

KÖRBER, LILI. Adventures in the East. *London* (John Lane, The Bodley Head), 1937. Pp. 347. 8½ × 5½ inches. 12s. 6d. net.

VIAL, L. G. Disposal of the dead among the Buant. *Oceania*, Vol. 7, pp. 64-68 + 1 plate, 1936.

VIAL, L. G. The dangagamun ceremony of the Wantoat. *Oceania*, Vol. 7, pp. 340-345 + 2 plates, 1937.

WHITING, ALFRED F. Hopi Indian agriculture II: Seed source and distribution. *Museum Notes (Museum of Northern Arizona)*, Vol. 10, pp. 13-16, 1937.

WILLIAMS, JOSEPH J., S.J. Africa's God. VI—Uganda. *Anthropological Series of the Boston College Graduate School*, Vol. 2, No. 3. *Chestnut Hill, Mass.* (Boston College Press), 1937. Pp. 44. 9¾ × 6½ inches. $1.00 (paper). [Bibliographic footnotes.]

IV. SOMATOLOGY AND CONSTITUTION

1. *Anatomy*

BACKMAN, GASTON. Die Lungenvenen der Wirbeltiere. Besonders der Säugetiere und des Menschen. *Lunds Universitets Årsskrift.* N. F. Avd. 2. Bd. 33, Nr. 6. *Lund* (C. W. K. Gleerup); *Leipzig* (Otto Harrassowitz), 1937. Pp. 112. 10¼ × 7¾ inches. Kr. 7 (paper). [Bibliography of 4 pages.]

DE BEER, G. R. The Development of the Vertebrate Skull. *New York* (Oxford University Press); *Oxford* (Clarendon Press), 1937. Pp. xxiv + 552 + 143 plates. 9¾ × 6½ inches. $10.00 [Bibliography and Index of Authors of 30 pages.]

BÖKER, HANS. Einführung in die vergleichende biologische Anatomie der Wirbeltiere. Zweiter Band. Biologische Anatomie der Ernährung. *Jena* (Gustav Fischer), 1937. Pp. xi + 258. 10 × 6¾ inches. RM. 13.50 (paper); RM. 15. (cloth). [Bibliography of 8½ pages.]

DAVENPORT, CHARLES B. A provisional hypothesis of child development. *Proceedings American Philosophical Society*, Vol. 75, pp. 537-548, 1935.

DAVENPORT, CHARLES B. Investigation on child development. *Carnegie Institution of Washington Year Book* No. 34, pp. 293-295, 1935. [Bibliography of 7 titles.]

DAVENPORT, CHARLES B. Investigation on child development. *Carnegie Institution of Washington Year Book* No. 35, p. 304, 1936. [Bibliography of 8 titles.]

FRANCIS, CARL C. Fundamentals of Anatomy. *St. Louis* (C. V. Mosby Co.), 1937. Pp. 320. 9 × 6 inches. $2.75.

GRANT, J. C. BOILEAU. A Method of Anatomy. Descriptive and Deductive. *Baltimore* (William Wood and Co.), 1937. Pp. xx + 650. 10 × 7 inches. $6.00.

LATIMER, H. B. A method of reviewing gross anatomy. *Journal of the Kansas Medical Society*, May, 1937. Pp. (of reprint) 3. [Bibliography of 4 titles.]

LATIMER, H. B., F. D. BATY, and C. T. JONES. An anomalous digastric muscle. *Journal of The Kansas Medical Society*, July, 1937. P. (of reprint) 1. [Bibliography of 4 titles.]

LATIMER, H. B., and P. H. WEDIN. An aortic arch with anomalous branches. *Journal of The Kansas Medical Society*, January, 1936. Pp. (of reprint) 3. [Bibliography of 6 titles.]

LIU, CHUNGSHEE H. On a hairy man of China. *Zeitschrift für Rassenkunde*, Bd. 6. pp. 339-340, 1937. [Bibliographic footnotes.]

YOUNG, HUGH H. Genital Abnormalities, Hermaphroditism and Related Adrenal Diseases. Drawings by William P. Didusch. *Baltimore* (Williams and

Wilkins Co.), 1937. Pp. xli + 649. 10 × 7 inches. $10.00 [Bibliography of 71 titles.]

2. Physical Anthropology and Anthropometry

ADACHI, BUNTARO. Das Ohrenschmalz als Rassenmerkmal und der Rassengeruch ("Achselgeruch") nebst dem Rassenunterschied der Schweissdrüsen. *Zeitschrift für Rassenkunde*, Bd. 6, pp. 273-307, 1937. [Bibliographic footnotes.]

ARENSBERG, CONRAD M. The Irish Countryman. An Anthropological Study. *New York* (The Macmillan Co.), 1937. Pp. xi + 216. 8½ × 5⅜ inches. $3.00.

BACKMAN, GASTON. Die Augenfarbe der Letten. *Lunds Universitets Årsskrift.* N. F. Avd. 2. Bd. 33, Nr. 3. *Lund* (C. W. K. Gleerup); *Leipzig* (Otto Harrassowitz), 1937. Pp. 64. 10¼ × 7¾ inches. Kr. 4 (paper). [Bibliography of 4½ pages.]

DAVENPORT, CHARLES B. How early in ontogeny do human racial characters show themselves? *"Eugen Fischer-Festband" (Zeitschrift für Morphologie und Anthropologie)*, Bd. 34, pp. 76-78, 1934. [Bibliography of 3 titles.]

DAVENPORT, CHARLES B. Variation in proportions among mammals, with special reference to man. *Journal of Mammalogy*, Vol. 16, pp. 291-296, 1935.

DAVENPORT, CHARLES B. Postnatal growth of the external nose. *Proceedings of the American Philosophical Society*, Vol. 78, pp. 61-77, 1937. [Bibliography of 1 title.]

DAVENPORT, CHARLES B. Anthropometry. Some principles of anthropometry. *American Journal of Physical Anthropology*, Vol. 23, pp. 91-99, 1937.

EDWARDS, LINDEN F., and RALPH G. SCHOTT. The daily rate of growth of toe nails. *Ohio Journal of Science*, Vol. 37, pp. 91-98, 1937. [Bibliography of 6 titles.]

GOLDSTEIN, MARCUS S. Weight. A survey of differences of method, instruments. *American Journal of Physical Anthropology*, Vol. 22, pp. 437-465, 1937. [Bibliography of 45 titles.]

LIU, CHUNGSHEE. A tentative classification of the races of China. *Zeitschrift für Rassenkunde*, Bd. 6, pp. 129-150, 1937. [Bibliography of 43 titles.]

SCHOONHEYT, L. J. A. Bijdrage tot de Anthropologie der Bevolking van Batavia en Naaste Omstreken. *Batavia-C* (Visser and Co.), 1937. Pp. [10] + 182 + 8 plates + 1 folding table. 9½ × 6 inches. [Bibliography of 60 titles.]

SCHULTZ, BRUNO K. Taschenbuch der rassenkundlichen Messtechnik. Anthropologische Messgeräte und Messungen am Lebenden. *Munich and Berlin* (J. F. Lehmanns), 1937. Pp. 102. 7½ × 5 inches. 6 marks (in Germany); 4.50 marks (outside Germany).

SEISOW, CHR. Rassenforschung in Bulgarien. *Zeitschrift für Rassenkunde*, Bd. 6, p. 245, 1937.

SELTZER, CARL C. A critique of the coefficient of racial likeness. *American Journal of Physical Anthropology*, Vol. 23, pp. 101-109, 1937. [Bibliography of 12 titles.]

STANTON, F. L., and M. S. GOLDSTEIN. Additional data on types of occlusion in a sample of the American population. *Journal of the American Dental*

Association and the Dental Cosmos, Vol. 24, pp. 1327-1335, 1937. [Bibliography of 5 titles.]

YOUNG, MATTHEW, ELSA JOHNSON, CORISANDE SMYTH, and MILDRED STILL. Investigations into the Nature and Characteristic Features of Post-Normal Occlusion. *Medical Research Council, Special Report Series,* No. 225. *London* (H. M. Stationery Office), 1937. Pp. 93. 9⅝ × 6⅛ inches. 1s. 6d. net (paper). [Bibliography of 7 titles.]

3. *Constitution*

NICEFORO, ALFREDO. Le Profil Graphique des Individus et des Groupes. Normalité et Anormalité. *Actualités Scientifiques et Industrielles,* 423. *Exposés de Biométrie et de Statistique Biologique,* X. *Paris* (Hermann et Cie), 1937. Pp. 51. 10 × 6½ inches. 12 francs (paper).

V. PHYSIOLOGY AND BIOCHEMISTRY

1. *Physiology*

ABDERHALDEN, EMIL. [Editor.] Handbuch der biologischen Arbeitsmethoden. Lieferung 464. Abt. V. Methoden zum Studium der Funktionen der einzelnen Organe des tierischen Organismus, Teil 7, Heft 13 (Schluss). Gehörsinn, Hautsinne, Kraftsinn (Muskelsinne), Geschmack- und Geruchsinn, Statischer Sinn, Stimme und Sprache. Containing following articles: Neue Verfahren zur Erforschung der Leistungen des Druck-, Temperatur-, Schmerz- und Kraftsinnes (Schluss), by Emil von Skramlik; Verfahren zur Prüfung der haptischen Leistungen, by Emil von Skramlik; Methoden zur Messung von Schall und Erschütterungen, by Hermann Reiher. *Berlin* (Urban und Schwarzenberg), 1937. Pp. 1821-2056. 10 × 7 inches. RM. 13.40 (paper). [Bibliographic footnotes.]

BERTWISTLE, A. P. The Rôle of Chemiotaxis in Bone Growth. *London* (Henry Kimpton), 1937. Pp. xii + 59. 9¾ × 6 inches. 8s. 6d. net. [Bibliography of 75 titles.]

BRODY, S., and E. A. TROWBRIDGE. Efficiency of Horses, Men, and Motors. *Missouri Agricultural Experiment Station, Bulletin* 383. *Columbia Mo.,* May, 1937. Pp. 24. [Bibliographic footnotes.]

CARLSON, ANTON J., and VICTOR JOHNSON. The Machinery of the Body. *Chicago* (University of Chicago Press), 1937. Pp. xvii + 580. 9 × 6¼ inches. $4.00. [List of "Selected References" of 1¼ pages.]

CIOCCO, ANTONIO. Nerve deafness from syphilis. *Laryngoscope,* Vol. 47, pp. 572-576, 1937. [Bibliography of 9 titles.]

CIOCCO, ANTONIO. Audiometric studies on school children. III. Variations in the auditory acuity of 543 school children re-examined after an average interval of three years. *Annals of Otology, Rhinology and Laryngology,* Vol. 46, pp. 55 ff., 1937. [Bibliography of 7 titles.]

CURSETJI, JEHANGIR J., and KHURSHED J. J. CURSETJI. Blood-Pressure in Life Assurance Practice. *Bombay* (Jehangir J. Cursetji), 1931. Pp. ii + 16. 7¼ × 4⅞ inches. 1s.; 50 cents (paper).

DOISY, EDWARD A. The ovarian follicular hormone. Mellon Lecture, *University of Pittsburgh School of Medicine.* Twentieth Lecture. Pp. (of reprint) 14, 1937.

DUFRENOY, J. Les phytohormones. *Annales Agronomiques,* May-June and July-August, 1937. Pp. (of reprint) 42. [Bibliography of 3 pages.]

FOUTS, PAUL J., O. M. HELMER, and L. G. ZERFAS. The secretion of hippuric acid in pernicious anemia. *American Journal of the Medical Sciences,* Vol. 193, pp. 647 ff., 1937. [Bibliography of 17 titles.]

FRANCIS, W. L. The origin of the electric potentials of organisms in iron: Electro-magnetic phenomena as the common basis of the physical sciences and of the life sciences. (*Issued at Brisbane,* August 30, 1937). Pp. 15. [Bibliography of 23 titles.]

FRANCIS, W. L. The surface membranes of muscle fibres. *Proceedings of the Royal Society of London,* Vol. 122, pp. 140-154, 1937. [Bibliography of 27 titles.]

FRIEDENWALD, JONAS S. Contribution to the theory and practice of tonometry. *American Journal of Ophthalmology,* Vol. 20, pp. 985-1024, 1937. [Bibliography of 20 titles.]

FROIN, G. Pression Solaire et Astrophysique. Les Maladies de la Nutrition. L'Eau en Physique et Biologie. *Paris* (Girardot et Cie), 1937. Pp. 352. 9½ × 6¼ inches. 35 francs (paper).

GOMEZ, E. T., and C. W. TURNER. Hypophysectomy and Replacement Therapy in Relation to the Growth and Secretory Activity of the Mammary Gland. *University of Missouri College of Agriculture, Agricultural Experiment Station, Research Bulletin* 259. *Columbia, Mo.,* May, 1937. Pp. 72. 9 × 6 inches. [Bibliography of 11¼ pages.]

HELMER, OSCAR M. The determination of vitamins B and G in human urine by the rat-growth method. *Journal of Nutrition,* Vol. 13, pp. 279-286, 1937. [Bibliography of 14 titles.]

HELMER, O. M., and PAUL J. FOUTS. Gastro-intestinal studies. VII. The excretion of xylose in pernicious anemia. *Journal of Clinical Investigation,* Vol. 16, pp. 343-349, 1937. [Bibliography of 18 titles.]

LIPSCHÜTZ, A. Prehipófisis masculina y femenina y tentativas experimentales de su neutralización. *Archives Portugaises des Sciences Biologiques,* T. 5, pp. 179-187, 1936. [Bibliography of 14 titles.]

LIPSCHÜTZ, A. Physiologie expérimentale.—Croissance atypique et destructive des glandes utérines après des interventions ovariennes expérimentales. *Comptes rendus des séances de l'Académie des Sciences,* T. 203, p. 1025 ff., 1936. [2 bibliographic footnotes.]

LIPSCHÜTZ, A. Épidermisation de la muqueuse du col utérin, après intervention ovarienne expérimentale. *Bulletin de l'Académie de Médecine,* T. 117, pp. 654 ff., 1937. [Bibliographic footnotes.]

MACNIDER, WM. DEB. A partial survey of investigations concerned with the formation of urine accompanied by certain deductions of a biological order. *The Diplomate,* January, 1937. Pp. (of reprint) 8. [Bibliography of 33 titles.]

MANN, FRANK C. The rôle of the liver as the commissariat of the body. Mellon Lecture, University of Pittsburg School of Medicine. Nineteenth Lecture.

American Journal of Digestive Diseases and Nutrition, Vol. 4, pp. 355-364, 1936. [Bibliography of 72 titles.]

MARSH, F., and P. A. BUXTON. Measurements of temperature and humidity between the clothes and the body. *Journal of Hygiene*, Vol. 37, pp. 254-260, 1937. [Bibliography of 1 title.]

REECE, R. P., and C. W. TURNER. The Lactogenic and Thyrotropic Hormone Content of the Anterior Lobe of the Pituitary Gland. *University of Missouri, College of Agriculture, Agricultural Experiment Station, Research Bulletin 266. Columbia, Mo.*, September, 1937. Pp. 104. 9 × 6 inches. [Bibliography of 8 pages.]

RIDDLE, O., R. W. BATES, J. P. SCHOOLEY, G. C. SMITH, E. L. LAHR, and M. W. JOHNSON. Endocrine studies. *Year Book, Carnegie Institution of Washington*, Vol. 35, pp. 49-56, 1936.

RIDDLE, O., and LOUIS B. DOTTI. Blood calcium in relation to anterior pituitary and sex hormones. *Science*, Vol. 84, pp. 557-559, 1936. [6 bibliographic footnotes.]

SOUTHALL, JAMES P. C. Introduction to Physiological Optics. *New York and London* (Oxford University Press), 1937. Pp. x + 426 + 3 plates. 9¼ × 6 inches. $5.50.

TURNER, C. W. Factors Affecting the Composition of Milk. *University of Missouri, College of Agriculture, Agricultural Experiment Station, Bulletin 365. Columbia, Mo.*, July, 1936. Pp. 30. 9 × 6 inches.

WENT, F. W., and KENNETH V. THIMANN. Phytohormones. *New York* (The Macmillan Co.), 1937. Pp. xi + 294. 8⅜ × 5½ inches. $4.00. [Bibliography of 33 pages.]

2. *Senescence, Senility and Longevity*

BAUER, E. Metabolic rate and duration of life of *Drosophilia*. IV. Metabolic rate and duration of life of *Drosophilia melanogaster* at different temperatures. *Archiv Biologicheskich Nauk*, Vol. 16, pp. 73-86, 1937. [Bibliography of 20 titles.]

CURSETJI, JEHANGIR J. Substandard Lives and Their Assessment in Life Assurance. Second Edition (Revised and Enlarged). *Bombay* (Jehangir J. Cursetji), 1929. Pp. v + 83 + v. 7⅛ × 4½ inches. 3s. 6d.; $1.25.

CURSETJI, JEHANGIR J. Assessment of Risks in Life Assurance Practices. *Bombay* (Jehangir J. Cursetji), 1937. Pp. 18. 7¼ × 4⅞ inches (paper).

EVANS, GERTRUDE. The relation between vitamins and the growth and survival of goldfishes in homotypically conditioned water. *Journal of Experimental Zoology*, Vol. 74, pp. 449-476. 1937. [Bibliography of 20 titles.]

KLUGER, JOSEF. Über abnormes Verhalten der Haarfarbe im Alter. *Alters-Forschung*, Heft 4, pp. 121-129, 1937. [Bibliography of 8 titles.]

KLUGER, JOSEF. Über Altersbestimmung und Wachstummsmessung bei Schildkröten. *Alters-Forschung*, Heft 4, pp. 129-131, 1937.

KLUGER, JOSEF. Zur Umgrenzung des Altersbegriffes. *Alters-Forschung*, Heft 4, pp. 132-135, 1937.

ROESLE, E. E. Die Grundlagen der vergleichenden Familienbiologie. VI. Das menschliche Normalalter und seine biologische Bedeutung. *Familienbiologie und Familienkulture*, Bd. 2, pp. 45-64, 1937.

SAVORGNAN, FRANCO. Die Altersgliederung des männlichen Zweiges der souveränen Geschlechter Ende 1935. *Allgemeines Statistisches Archiv*, Bd. 27, pp. 16-22, 1937. [Bibliographic footnotes.]

WINBERG G., and A. P. SHCHERBAKOV. The metabolic rate and the duration of life in three species of *Drosophila*. *Zoological Journal* [Russian], Vol. 16, pp. 311-323, 1937. [Bibliography of 20 titles.]

3. *Biochemistry*

BUCHY, MARIE-THÉRÈSE. Les agents régulateurs du métabolisme azoté. I. L' adrénaline. *Archives Internationales de Physiologie*, Vol. 44, pp. 139-173, 1937. [Bibliography of 46 titles.]

CHABRE, PAUL. Les Huiles de Foie de Morue. Leur Teneur en Vitamines A et D. Preface by A. Chevallier. *Paris* (Masson et Cie), 1936. Pp. 207. 9¾ × 6½ inches. 36 francs (paper). [Bibliography of 4¼ pages.]

DANIEL, ESTHER P., and HAZEL E. MUNSELL. Vitamin Content of Foods. A Summary of the Chemistry of Vitamins, Units of Measurement, Quantitative Aspects in Human Nutrition and Occurrence in Foods. *U. S. Department of Agriculture. Miscellaneous Publication*, No. 275. *Washington* (Government Printing Office), 1937. Pp. 175. 10 × 6¾ inches. 15 cents (paper). [Bibliography of 771 titles.]

GRIGNARD, V., G. DUPONT, R. LOCQUIN, and PAUL BAUD. [Published under the direction of.] Traité de Chimie Organique. Tome V. Les Métaux en Chimie Organique. Alcools dans Toutes les Séries. Formation des Alcools par Voie Biochimique. Synthèse du Méthanol. Industrie de l'Alcoolé Thylique. Éthers-Oxydes. Éthers-Sels des Acides Minéraux. By P. Baud, Ch. Courtot, Cl. Fromageot, J. Lichtenberger, Ch. Prévost, J. B. Senderens. *Paris* (Masson et Cie), 1937. Pp. xix + 1047. 10 × 6½ inches. 310 francs. [Bibliography at end of each chapter.]

HARRISON, ROGER W., ANDREW W. ANDERSON, ARTHUR D. HOLMES, and MADELEINE G. PIGOTT. Vitamin Content of Oils from Cannery Trimmings of Salmon from the Columbia River and Puget Sound Regions. *U. S. Department of Commerce, Bureau of Fisheries, Investigation Report* No. 36. *Washington* (Government Printing Office), 1937. Pp. ii + 8. 9¼ × 6 inches. 5 cents. [Bibliography of 12 titles.]

HOLMES, ARTHUR D., FRANCIS TRIPP, and G. HOWARD SATTERFIELD. Vitamin A content of cod liver oil. *Industrial and Engineering Chemistry*, Vol. 9, p. 456 ff., 1937. [Bibliography of 9 titles.]

LELU, PAULE. Valeur de la méthode de Hanke et Koessler pour l'appréciation de l'imidazolurie. *Bulletin de la Société de Chimie biologique*, Vol. 18, pp. 1636-1649, 1936. [Bibliography of 5 titles.]

LELU, PAULE. Le métabolisme de l'imidazol. II. Imidazolurie comparée chez diverses espèces animales (carnivores, herbivores, omnivores). *Bulletin de*

la Société de Chimie biologique, Vol. 18, pp. 1871-1884, 1936. [Bibliography of 6 titles.]

LELU, PAULE. Le métabolisme de l'imidazol. III. L'origine digestive ou métabolique de l'imidazolurie chez diverses espèces animales. *Bulletin de la Société de Chimie biologique*, Vol. 19, pp. 292-302, 1937. [Bibliography of 6 titles.]

LELU, PAULE. Le métabolisme de l'imidazol. IV. Vitesse horaire de l'imidazolurie dans le métabolisme protéique oxogène. *Bulletin de la Société de Chimie biologique*, Vol. 19, pp. 490-495, 1937. [Bibliography of 6 titles.]

NEEDHAM, JOSEPH, and DAVID E. GREEN [Editors.] Perspectives in Biochemistry. Thirty-one essays presented to Sir Frederick Gowland Hopkins by past and present members of his laboratory. *Cambridge* (University Press); *New York* (The Macmillan Co.), 1937. Pp. x + 361 + 6 plates. 8½ × 5½ inches. $4.75. [Bibliography at end of each chapter.]

NORMAN, A. G. The Biochemistry of Cellulose, the Polyuronides, Lignin, etc. *New York* (Oxford University Press); *Oxford* (Clarendon Press), 1937. Pp. viii + 232. 9¼ × 6¼ inches. $5.00. [Bibliographic footnotes throughout.]

PAGE, IRVINE H. Chemistry of the Brain. *Springfield, Ill.* (Charles C Thomas), 1937. Pp. xvii + 444. 10 × 6⅜ inches. $7.50. [Bibliographic footnotes throughout.]

RHODEHAMEL, ROBERT H., CHARLES L. ROSE, and K. K. CHEN. A rapid method of estimating urine sugar. *Medical Record*, Vol. 145, pp. 324-325, 1937. [Bibliography of 4 titles.]

SYNEPHIAS, SIMONE. La participation relative des protides et des lipides à la couverture des dépenses énergétiques dans l'inanition. *Bulletin de la Société de Chimie biologique*, Vol. 19, pp. 1037-1058, 1937. [Bibliography of 16 titles.]

TERROINE, E. F., ANNE-MARIE DE LA BERNADIE, and PAULE LELU. Le métabolisme de la créatinine et de la créatine en fonction de la grandeur de la thermogenèse. *Archives Internationales de Physiologie*, Vol. 45, pp. 247-272, 1937. [Bibliography of 6 titles.]

TERROINE, E. F., and R. BONNET. Les agents régulateurs du métabolisme azoté. II. La thyroxine. *Archives Internationales de Physiologie*, Vol. 44, pp. 265-312, 1937. [Bibliography of 71 titles.]

TERROINE, E. F., and J. FIRDMAN. L'allure du rejet des diverses substances excrémentitielles dans le catabolisme protéique exogène. *Bulletin de la Société de Chimie biologique*, Vol. 19, pp. 259-291, 1937. [Bibliography of 35 titles.]

4. *Pharmacology*

BURRIN, P. L., A. G. WORTON, and F. E. BIBBINS. Stabilized syrup of ferrous iodide. *Journal of the American Pharmaceutical Association*, Vol. 25, pp. 1102-1104, 1936. [Bibliography of 4 titles.]

CHEN, K. K., ROBERT C. ANDERSON, and T. Q. CHOU. The pharmacological action of four corydalis alkaloids. *Chinese Journal of Physiology*, Vol. 11, pp. 7-12, 1937. [Bibliography of 8 titles.]

CHEN, K. K., ROBERT C. ANDERSON, and E. BROWN ROBBINS. The potency of five additional cardiac glucosides, calotropin, alpha-antiarin, emicymarin, folinerin and sarmentocymarin. *Journal of the American Pharmaceutical Association*, Vol. 26, pp. 214-218, 1937. [Bibliography of 13 titles.]

CHEN, K. K., and A. LING CHEN. The chemistry of Mu-fang-chi. *Chinese Journal of Physiology*, Vol. 11, pp. 25-28, 1937. [Bibliography of 5 titles.]

CHEN, K. K., A. LING CHEN, ROBERT C. ANDERSON, and CHARLES L. ROSE. The pharmacological action of tetrandrine, an alkaloid of Han-fang-chi. *Chinese Journal of Physiology*, Vol. 11, pp. 13-24, 1937.

CHEN, K. K., and T. Q. CHOU. The action of toxicity of menisine and menisidine. *Chinese Journal of Physiology*, Vol. 11, pp. 29-34, 1937.

HOOPER, DAVID. Useful Plants and Drugs of Iran and Iraq. *Field Museum of Natural History, Publication* 387. Volume IX, Number 3. Notes by Henry Field. *Chicago* (Field Museum of Natural History), 1937. Pp. 173. 9½ × 6¼ inches. $1.50 (paper).

MACNIDER, WM. DEB. A study of the acquired resistance of fixed tissue cells morphologically altered through processes of repair. IV. Concerning the persistence of an acquired type of atypical liver cell with observations on the resistance of such cells to the toxic action of chloroform. *Journal of Pharmacology and Experimental Therapeutics*, Vol. 59, pp. 393-400 + 2 plates, 1937. [Bibliography of 6 titles.]

TERROINE, E. F., and GERMAINE BOY. La pharmacodynamie du métabolisme azorté. I. Action de la phlorhizine. *Archives Internationales de Pharmacodynamie et de Thérapie*, Vol. 55, pp. 76-103, 1937. [Bibliography of 32 titles.]

VOLLRATH, RICHARD E., LUCILE WALTON, and CARL C. LINDEGREN. Bactericidal properties of acrolein. *Proceedings of the Society for Experimental Biology and Medicine*, Vol. 36, pp. 55-58, 1937. [Bibliographic footnotes.]

VI. PATHOLOGY, CLINICAL MEDICINE AND SURGERY

CHIDESTER, F. E. Iodine in relation to immunity. *Medical World*, May, 1935, pp. 320-322. [Bibliography of 31 titles.]

CLAOUÉ, C. Brustplastik. *Archiv für Klinische Chirurgie*, Bd. 189, pp. 538-547, 1937.

CURSETJI, JEHANGIR J. A Pocket Guide to Medical Life Assurance. Third Edition (re-written and considerably enlarged). *Bombay* (Jehangir J. Cursetji), 1932. Pp. vii + 274. 7½ × 4⅞ inches. 9s. 6d.; $4.00 (cloth); 8s.; $3.50 (paper).

DUNNING, WILHELMINA F. The origin of malignancy, somatic mutations, genes and viruses. *The Medical Woman's Journal*, May, 1937. Pp. (of reprint) 8. [Bibliography of 24 titles.]

FOUTS, PAUL J. Pernicious anemia and its treatment. *Journal of the Indiana State Medical Association*, Vol. 30, pp. 22-23, 1937.

HEGNER, ROBERT. Parasite reactions to host modifications. *Journal of Parasitology*, Vol. 23, pp. 1-12, 1937.

MEDICAL RESEARCH COUNCIL. Medical Uses of Radium. Summary of Reports from Research Centres for 1936. *Medical Research Council, Special Report*

Series, No. 226. *London* (H. M. Stationery Office), 1937. Pp. 41 + 2 plates. 9⅞ × 6⅛ inches. 1s. 0d. net (paper).

MURDOCH, A. The Function of the Sub-Occipital Muscles. The Key to Posture, Use and Functioning. *Bexhill-on-Sea, Sussex, London* (A. Murdoch), 1937. Pp. 19. 8½ × 5½ inches (paper).

PELLER, SIGISMUND, and CHARLES S. STEPHENSON. Skin irritation and cancer in the U. S. Navy. *American Journal of the Medical Sciences*, Vol. 194, pp. 326-333, 1937. [2 bibliographic references.]

POWELL, H. M., and W. A. JAMIESON. Further studies on the immunology of *Hemophilus pertussis*. *Journal of Immunology*, Vol. 32, pp. 153-156, 1937. [Bibliography of 6 titles.]

SHWARTZMAN, GREGORY. Phenomenon of Local Tissue Reactivity and Its Immunological, Pathological and Clinical Significance. Foreword by Jules Bordet. *New York* (Paul B. Hoeber, Medical Book Dept. of Harper and Bro.), 1937. Pp. xviii + 461. 9¼ × 6⅛ inches. $7.50. [Bibliography of 14¼ pages.]

SMITHLINE, JACOB. Prophylaxis and medical treatment of cancer. *Medical Record*, September 1, 1937. Pp. (of reprint) 18. [Bibliography of 15 titles.]

SNODGRASS, W. R., and R. J. PETERS. An Analysis of the Results of Treatment of Early, Latent, and Muco-Cutaneous Tertiary Syphilis. *Medical Research Council, Special Report Series*, No. 224. *London* (H. M. Stationery Office), 1937. Pp. 126. 9⅝ × 6⅛ inches. 2s. net (paper). [Bibliography of 14 titles.]

VII. METHODOLOGY

1. *Mensurational and Observational*

DAVENPORT, CHARLES B. An improved technique for measuring head features. *Growth*, Vol. 1, No. 2, 1937. Pp. (of reprint) 5.

HALL, R. P., D. F. JOHNSON, and J. B. LOEFER. A method for counting protozoa in the measurement of growth under experimental conditions. *Transactions of the Microscopical Society*, Vol. 54, pp. 298-300, 1935. [Bibliography of 9 titles.]

2. *Mathematical and Statistical*

BRELOT, M. Sur l'influence des erreurs de mesure en statistique et biométrie. *Bulletin des Travaux publiés par la Station d'Aquiculture et de pêche de Castiglione*, 1937. Pp. (of reprint) 32. [Bibliographic footnotes.]

CAMP, B. H. Methods of obtaining probability distributions. *Annals of Mathematical Statistics*, Vol. 8, pp. 90-102, 1937. [Bibliography of 31 titles.]

CAMP, B. H. Levy and Roth on probability. *Bulletin of the American Mathematical Society*, July, 1937, pp. 454-456.

COMPTON, H. B., and C. O. DOHRENWEND. Solution of the Elastic Curve Equation, $M = EI \frac{d^2y}{dx^2}$. *Rensselaer Polytechnic Institution Bulletin* No. 54. *Troy, N. Y.*, September, 1937. Pp. 25. 8⅝ × 5¾ inches.

CONRAD, HERBERT S., and RUTH H. KRAUSE. An extension of the Kelly-Wood and Kondo-Elderton tables of abscissae of the unit normal curve, for areas ($\frac{1}{2}a$) between .4500 and .49999 99999. *Journal of Experimental Education*, Vol. 5, pp. 278-285, 1937. [Bibliography of 19 titles.]

DUFRENOY, J. Conception statistique de la liberté en biologie. *Journal de la Société de Statistique de Paris*, Vol. 79, pp. 260-288, 1937. [Bibliography of 1 page.]

KRAUSE, RUTH H., and HERBERT S. CONRAD. A seven-decimal table of the area (a) under the unit normal curve, for abscissae expressed in terms of P. E. *Psychometrika*, Vol. 2, pp. 55-66, 1937. [Bibliography of 34 titles.]

TIPPETT, L. H. C. The Methods of Statistics. An Introduction Mainly for Experimentalists. Second Edition Revised and Enlarged. *London* (Williams and Norgate), 1937. Pp. 280. 8½ × 5½ inches. 15s. net. [Bibliography of 3½ pages.]

YULE, G. UDNY, and M. G. KENDALL. An Introduction to the Theory of Statistics. Eleventh Edition, Revised Throughout and Re-set. *London* (Charles Griffin and Co.), 1937. Pp. xiii + 570 + 4 folding plates. 8¾ × 6 inches. 21s. net. [Bibliography of 34 pages.]

3. *Other and General*

GATENBY, J. BRONTË, and THEOPHILUS S. PAINTER [Editors], with the collaboration of D. G. CATCHESIDE, HAROLD J. CONN, E. S. DUTHIE, HELEN PIXELL-GOODRICH, J. G. GREENFIELD, W. W. KAY, REGINALD LUDFORD, K. C. RICHARDSON, RUBY O. STERN, and RAYMOND WHITEHEAD. The Microtomist's Vade-Mecum (Bolles Lee). A Handbook of the Methods of Animal and Plant Microscopic Anatomy. Tenth Edition. *Philadelphia* (P. Blakiston's Son and Co.), 1937. Pp. xi + 784. 8¾ × 5½ inches. $9.00.

LATIMER, H. B. Decalcification as a method of preparation of gross anatomical material. *Science*, Vol. 83, pp. 583-584, 1936. [3 bibliographic footnotes.]

PETERS, H. B. Lateinische Neubenennungen von Menschenrassen. *Zeitschrift für Rassenkunde*, Bd. 6, p. 151, 1937.

PETERS, H. B. Die wissenschaftlichen Namen der menschlichen Körperformgruppen. Eine Zusammenstellung nach den internationalen Nomenklaturregeln. *Zeitschrift für Rassenkunde*, Bd. 6, pp. 211-241, 1937. [Bibliography of 2 pages.]

U. S. DEPARTMENT OF COMMERCE, BUREAU OF THE CENSUS. Instruction Manual. Third Edition. Procedure and Rules Used in the Division of Vital Statistics for Coding Mortality and Natality Transcripts and Punching Machine Tabulation Cards. *Washington*, September 15, 1937.

U. S. DEPARTMENT OF LABOR, CHILDREN'S BUREAU. American registry of physical therapy technicians. *Archives of Physical Therapy, X-Ray, Radium*, Vol. 18, pp. 305-307, 1937.

VIII. GENERAL AND MISCELLANEOUS

BRAND, DONALD D. [Editor.] New Mexico Anthropologist. Volume 2, Number 1. *Albuquerque* (Department of Anthropology, University of New Mexico), 1937. Pp. 32. 9 × 6 inches. Single copies, 35 cents; Year, $1.25.

HENTSCHEL, C. C., and W. R. IVIMEY COOK. Biology for Medical Students. Second Edition. With a Foreword by G. E. Gask. *New York* (Longmans, Green and Co.), 1937. Pp. xii + 664. 8½ × 5½ inches. $7.50.

SPRATT, E. R., and A. V. SPRATT. General Science—Biology. *London* (University Tutorial Press), 1937. Pp. vii + 216. 7¼ × 4¾ inches. 2s. 6d.

SUMNER, FRANCIS B. The new dogmatism. *Scientific Monthly*, Vol. 45, pp. 342-348, 1937.

WHITE, E. GRACE. A Textbook of General Biology. Second Revised Edition. *St. Louis* (C. V. Mosby Co.), 1937. Pp. 667. 8½ × 5½ inches. $3.00. [Bibliography of 124 titles.]